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2P-1L

Highway Safety Literature

An Announcement of Recent Acquisitions . . .

HSL No. 71-26
October 8, 1971



THIS ISSUE CONTAINS:

HS-009 820 - HS-009 915
HS-800 475 - HS-800 481
HS-810 164

HIGHWAY SAFETY LITERATURE

AN ANNOUNCEMENT OF RECENT ACQUISITIONS

Published Bi-Weekly (26 times a year) by the National Highway Traffic Safety Administration
Washington, D.C. 20590

INTRODUCTION

Publications announced in *Highway Safety Literature* include the most recent additions to the collection of the NHTSA Scientific & Technical Information Service. Subject areas covered include all phases of highway, motor vehicle, and traffic safety, especially those encompassed by the National Traffic and Motor Vehicle Safety Act of 1966 and the Highway Safety Act of 1966.

Individual issues of *HSL* are numbered according to the year and the issue number within that year; thus, 71 designates the year and 1, 2, 3, etc. the individual issues. To aid the user in location citations by the HS-number, the cover bears the inclusive entry numbers for each issue.

Entries in *HSL* are arranged according to the revised NHTSA Subject Category List shown in the Table of Contents. The List is a two-level arrangement consisting of five major subject fields subdivided into 59 subject groups. Documents related directly to the National Highway Traffic Safety

Administration (NHTSA) are announced in a separate section headed NHTSA DOCUMENTS and are numbered in five distinct series: NHTSA Accident Investigation Reports (HS-600 000 series), NHTSA Compliance Test Reports (HS-610 000 series), NHTSA Contractors Reports (HS-800 000 series), NHTSA Staff Speeches, Papers, etc. (HS-810 000 series), and NHTSA Imprints (HS-820 000 series). For NHTSA DOCUMENTS in series HS-600 000 and HS-610 000, individual full case reports are available for inspection at the National Highway Traffic Safety Administration. HS-800 000 series and HS-820 000 series are available for sale/or purchase from NTIS or GPO (see page ii). Although announced together in a separate section, these documents are also assigned specific subject categories for machine retrieval.

A document which contains a number of separate articles is announced as a complete volume in the subject category most applicable to it as a whole. Entries for the individual articles appear in their most specific subject category.

SAMPLE ENTRIES

Subject Category Array

HS-800 218 Fld. 5/21; 5/9

NHSB Accession no.....

AN INVESTIGATION OF USED CAR
SAFETY STANDARDS-SAFETY
INDEX: FINAL REPORT. VOL. 6 -
APPENDICES G-L

Personal author(s).....

by E. N. Wells; J. P. Fitzmaurice; C. E.
Guilliams; S. R. Kalin; P. D. Williams

Corporate author.....

Operations Research, Inc.

Collation

12 Sep 1969 150p
Contract FH-11-6921
Report no. ORI-TR-553-Vol-6; PB-190
523

Abstract.....

Appendices G-L to this study of used
car safety standards include: indenture
model diagrams for classes I-IV motor
trucks; degradation, wear, and failure
data for motor truck classes I-IV; and
safety index tables for classes I-IV
motor trucks.

Search terms; Wear; Trucks
Failures; Used cars; Inspection
standards

HS-004 497 Fld. 5/19

AUTO THEFT--THE PROBLEM
AND THE CHALLENGE

by Thomas A. Williams, Sr.

Journal citation . . . Published in *FBI Law Enforcement*
Bulletin v37 n12 p15-7 (Dec 1968)

Gives figures on the extent of the
auto theft problem and comments on
antitheft devices available now or in
the planning stage.

Search terms: Theft; Theft protec-
tion; Stolen cars

AVAILABILITY: NTIS

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NOTE: Material published in Highway Safety Literature (HSL) is intended for the information and assistance of the motor vehicle and highway safety community. While brands names, equipment model names and identification, and companies may be mentioned from time to time, this data is included as an information service. Inclusion of this information in the HSL should not, under any circumstances, be construed as an endorsement or an approval by the U. S. Department of Transportation, National Highway Traffic Safety Administration of any particular product, course, or equipment.

Harry A. Feinberg
Managing Editor

AVAILABILITY OF DOCUMENTS AND INSTRUCTIONS FOR ORDERING

Department of Transportation personnel may borrow copies of publications directly from the NHTSA. Outside the Washington, D.C. area, phone (202) 426-2768. In Washington, D.C. area, use government ID, phone 118-62768. Non-DOT personnel should contact their company or agency libraries for assistance.

Journals cite^d may be obtained through most research libraries.

Contractors' reports and other documents can usually be obtained as indicated under AVAILABILITY. However, there is no certainty that retention copies will be available for more than a limited period after a document is issued.

The more common distribution sources are identified by symbols which are explained below:

NTIS: National Technical Information Service, Springfield, Va. 22151. *Order by accession number: HS, AD, or PB.* Prepayment is required by NTIS (CFSTI) coupon (GPO coupons are not acceptable), check, or money order (made payable to the NTIS), *HC* (Paper copy; full size original or reduced facsimile) \$3.00 up; *MF* (microfiche approximately 4x6" negative sheet

film; reader required) \$0.95.

GPO: Superintendent of Documents, U.S. Government Printing Office, Washington, D. C. 20402. Give corporate author, title, personal author, and report number. Prepayment is required by GPO coupon (NTIS [CFSTI] coupons are not acceptable), check or money order (made payable to the Superintendent of documents).

HRB: Highway Research Board, National Academy of Sciences, 2101 Constitution Ave., N. W., Washington, D. C. 20418.

NHTSA: National Highway Traffic Safety Administration General Services Division, Washington, D.C. 20591 (Telephone (202) 426-0874),

SAE: Society of Automotive Engineers, Dept. HSL, 2 Pennsylvania Plaza, New York, N.Y. 10001. Order by SAE report numbers. Prices given are list; discounts are available to members and sometimes to libraries and U. S. Government Agencies. Prepayment is required; orders without payment are subject to a \$1 handling charge.

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WHEN REQUESTING a document, to be absolutely sure you receive what you order, give the accession number (HS, PB, AD number) or report number (in cases such as an SAE document), title of report, and the personal or corporate author (whichever is cited). When requesting an HS-numbered document from NTIS (CFSTI), add DOT/to the prefix HS-; example HS-800 000 should be ordered as DOT/HS-800 000.

OCTOBER 8, 1971

ACCIDENTS

1/0 ACCIDENTS

1/1 Emergency Services

HS-009 820 Fld. 1/1

THE INTERDISCIPLINARY DEVELOPMENT OF AMBULANCE DESIGN CRITERIA

by John E. Baerwald

Published in *Highway Research Record* n332 p54-62 (1970)

7 refs

Sponsored by HRB and presented at its 49th annual meeting.

The wide variation in ambulance equipment and regulation of ambulance services, coupled with the development of federal safety standards for all types of vehicles operating on the highways, resulted in the National Academy of Engineering being asked to undertake a study of ambulance design criteria. This study was performed by an interdisciplinary committee consisting of physicians, ambulance operators, automotive engineers, and specialists in related fields. In addition to describing the organization and activities of the committee, this paper summarizes the major ambulance design criteria recommended by the committee and concludes with a listing of the elements essential for successful interdisciplinary efforts to solve a specific problem.

Search terms: Ambulance design; Emergency medical services; Multidisciplinary teams

HS-009 821 Fld. 1/1

AMBULANCE SERVICE IN VERMONT

by Julian A. Waller; Lee Jacobs

Vermont Univ.; Vermont Dept. of Health

1970 50p 4 refs

Supported by a grant from the Insurance Institute for Highway Safety.

The purposes of this report are three-fold. First, it describes briefly what is known about the quality of emergency health services available to a group of individuals who were fatally injured on the Vermont roads during 1966 and 1967. Second, it surveys the existing pattern of ambulance services in Vermont and the currently unmet needs for better emergency services. Lastly, it provides a summary of the past program and future plans of the Vermont State Health Department to improve emergency health services in Vermont. It is estimated that nearly 25% of the highway fatalities died of survivable injuries. The inadequacies in first aid, equipment, and trained personnel in the present ambulance services are described.

Search terms: Ambulances; Ambulance personnel training; Emergency medical services; Transportation of injured; First aid; Emergency equipment; Fatalities; Vermont; Accident survivability

1/2 Injuries

HS-009 822 Fld. 1/2

TOLERANCES FOR CEREBRAL CONCUSSION FROM HEAD IMPACT AND WHIPLASH IN PRIMATES

by A. K. Ommaya; A. E. Hirsch

Published in *Journal of Biomechanics* v4 n1 p13-21 (1971)

12 refs

Experimental head impact and whiplash injury experiments have been conducted in three sub-human primate species in order to define tolerance thresholds for onset of cerebral concussion. Preliminary analysis of data supports a hypothesis that approximately half of the potential for brain injury during impact to the unprotected movable head is related to head rotation; the remaining brain injury

potential of the blow is related to the contact phenomena of the impact. Data derived in these experiments are compared with values predicted from some scaling considerations previously developed. Predictions are made that the levels of head rotation during whiplash, in excess of 1,800 rad./sec², will probably result in cerebral concussion in man.

Search terms: Head impact tolerances; Whiplash injuries; Brain injuries; Head movement; Animal experiments; Animal impact tolerances; Brain concussion; Primates; Animal acceleration tolerances

1/3 Investigation

HS-009 823 Fld. 1/3

THE INFLUENCE OF SOCIETAL VALUES ON RATES OF DEATH AND INJURY

by David Klein

Published in *Journal of Safety Research* v3 n1 p2-8 (Mar 1971)

8 refs

Presented at the annual meeting of the American Public Health Assn., Houston, 28 Oct 1970.

American cultural values do not favor as safe an environment as could be achieved with existing technology. Risk and danger are tolerated, and there is growing discrepancy between cultural values and social reality. Despite an increasingly technological urban environment, children are still taught values evolved in a frontier society. The increase in mechanically powerful devices, including cars, the importance of cars to young male drivers, the role of violence in American society, and the implications of these factors for safety are discussed.

Search terms: Value analysis; Psychological factors; Sociological factors; Risk taking; Adolescent drivers; Male drivers; Violence; Automobile cultural

1/3 Investigation (Cont'd.)

HS-009 823 (Cont'd.)

role; Accident factors; Injury rates; Fatality rates

HS-009 824 Fld. 1/3

HIGHWAY ACCIDENT REPORT, TWO-CAR COLLISION, SOUTHERN APPROACH TO GOLDEN GATE BRIDGE, SAN FRANCISCO, CALIFORNIA, JULY 11, 1970

National Transp. Safety Board

10 Feb 1971 46p

Report no. NTSB-HAR-71-5; SS-II-9

A 1970 Porsche Targa (911-T) southbound off the Golden Gate Bridge at 12:30 a.m., July 11, 1970, accelerated to over 100 miles per hour. On a left curve of 1470-foot radius the driver apparently lost control, causing a left swerve and counterclockwise spin and skid into opposing (northbound) traffic lanes. A northbound Mustang with nine young people aboard was struck nearly head-on. All three persons in the Porsche and seven of the nine in the Mustang were fatally injured. Both drivers had been drinking, but their blood alcohol levels were below the .10% presumptive level of impairment under California law. The highway, built in 1937, had lanes 10 feet wide as against a current standard of 12 feet, and there was no median barrier or guardrail. Excessive speed of the Porsche led to loss of vehicle control on the curve of a highway which had substandard lane width and no median barrier.

Search terms: California; Bridge approaches; Head on collisions; High speed caused accidents; Accident investigation; Blood alcohol levels; Fatalities; Loss of control caused accidents; Drinking drivers; Accident causes; Accident location; Accident reports; Crushing; Environmental factors; Vehicle kinematics; Lane width

AVAILABILITY: NTIS \$3.00

HS-009 825 Fld. 1/3; 2/9; 1/4

THE TRAFFIC CONFLICTS TECHNIQUE APPLIED TO RURAL INTERSECTIONS

by R. E. Campbell; L. Ellis King

Published in *Accident Analysis and Prevention* v2 n3 p175-88 (Dec 1970)

4 refs

Potential accident locations can be identified before accident statistics are available, with their accompanying injuries, fatalities, and damages. Developed for four-way intersections, the traffic conflicts technique also can be applied to Y intersections, both urban and rural. This study was limited to two rural, Y-type intersections known to have a sight distance and/or accident problem. The traffic conflicts technique is a systematic method of observing traffic at an intersection to determine the site's accident potential. Traffic conflicts are potential accident situations identified by evasive actions (braking or lane change) to avoid collisions, or traffic violations such as not halting for a stop sign. The data were collected by a two-man team parked inconspicuously about 300 feet away using hand counters and data forms. Statistical comparison between the night and day studies and the authors' observations indicated that conflicts per vehicle was a fairly stable measure of accident potential.

Search terms: Accident prevention; Accident risk forecasting; Accident research; Accident location; Intersections; Rural intersections; Day vs night performance; Accident factors; Accident avoidance; Traffic surveillance; Traffic conflicts

HS-009 826 Fld. 1/3; 3/5; 1/5

A BEFORE AND AFTER ANALYSIS OF ACCIDENTS INVOLVING STUDENTS OF THE DEFENSIVE DRIVING COURSE

by James O'Day

Published in *Accident Analysis and Prevention* v2 n3 p175-88 (Dec 1970)

3 refs

An investigation of the efficacy of the National Safety Council's defensive driving course as taught in the Baltimore area was undertaken in 1967 by the Highway Safety Research Institute. A mail survey was used (as opposed to personal interview) to collect information on individual driver experience and to verify a small sample of these driver reports through state records of accidents and violations. The conclusions were that the course had not been useful to the Baltimore community. The reported accident rate rose, and a test of the official records did not disclose any obvious bias. Similarly little difference in the internal features of accidents (seat-belt wearing, injury index, drinking, culpability) was found. There was a change in accident pattern that warrants further investigation.

Search terms: Defensive drinking; Driver improvement; Driver performance; Accident types; Accident records; Baltimore; Driver education; Questionnaires; Seat belt usage; Chi square test; Accident statistics; Driver characteristics

HS-009 827 Fld. 1/3; 3/12

ANALYSIS OF COLLISIONS INVOLVING REAR VISION

by Rudolf G. Mortimer; Thomas J. Vander May

Published in *HIT Lab Reports* p4-5 (Mar 1971)

The proportion and severity of accidents believed to involve rear vision were analyzed. The data were taken from Michigan's Oakland and Washtenaw counties. In these counties, respectively, less than 3.0% and 1.4% of all two-or-more-vehicle collisions involved rear vision; the severity of these collisions was less than the average of the other two-or-more-vehicle collisions. We con-

clude that these rear-vision collisions may be reduced by improving the field of view to the rear, particularly the right rear. Low-cost methods, such as convex mirrors, seem to be warranted based on the accident analysis and on experimental studies.

Search terms: Rear visibility; Convex mirrors; Rearview mirrors; Lane changing accidents; Passing; Reduced visibility caused accidents; Vehicle vehicle collisions; Accident severity; Field of view; Accident analysis; Michigan; Multiple vehicle accidents

HS-009 828 Fld. 1/3; 3/12; 5/10

ACCIDENT EXPERIENCE WITH PARKING LIGHTS AS RUNNING LIGHTS

by Edmund J. Cantilli

Published in *Highway Research Record* n332 p1-13 (1970)

3 refs

Presented at HRB 49th annual-meeting.

An attempt to test the need for better visual definition of the automotive vehicle through the use of running lights during daylight hours is reported. In lieu of the addition of special lighting systems, the parking lights and taillights of some 200 motor vehicles were made to turn on automatically on ignition. After one year, observation of these vehicles, and of about 400 unmodified vehicles as a control group, gave results indicating that the modified vehicles as a group had a better accident rate (some 18 percent better overall) and a better severity rate (66 percent lower on a numerical scale) than the unlighted vehicles. Specifically, the rear-end accident rate was reduced by 45 percent, with significant reductions of other accident types. Variation of type of vehicle and color of vehicle are also discussed.

Search terms: Vehicle visibility; Rear end collisions; Head on collisions; Side impact collisions; Accident rates; Vehi-

cle lighting; Running lamp daytime usage; Accident severity; Taillamps; Accident prevention; Parking lamps; Automobile colors

HS-009 829 Fld. 1/3; 4/8

THE TRAFFIC ENGINEER'S ROLE IN ACCIDENT PREVENTION — THE CITY PLANNER'S RESPONSIBILITY

by Henry A. Barnes

New York City Office of the Commissioner of Traf.

1963 4p

Advance paper prepared for presentation at Liberty Mutual's Council on the Automobile and Public Health, Panel 4, Boston, 22 Nov 1963.

Traffic engineers, aware of the relationship between congestion and accidents, are using every available device to establish and maintain orderly traffic flows and to reduce the 40,000 annual motor fatalities. However, the city planner often refuses to approve proposals made by the traffic engineer designed to relieve congestion. The traffic engineer's responsibility is to eliminate existing hazardous conditions. The city planner's responsibility is to prevent new ones from being created. If the planner and engineer worked closely from the inception of a plan for urban expansion or renewal, greater safety value would accrue to both motorist and pedestrian.

Search terms: Urban planning; Traffic engineering; Traffic congestion; Urban renewal; Urban traffic flow; Accident prevention; Pedestrian accidents; Pedestrian safety

1/4 Locations

HS-009 830 Fld. 1/4

A COMPARISON OF DIRECT AND INDIRECT METHODS FOR

DETERMINING ACCIDENT POTENTIAL

by Juergen Pahl

Published in *Accident Analysis and Prevention* v2 n3 p201-7 (Dec 1970)

14 refs

The accident rate is a fundamentally important measure in the evaluation of safety performance, safety trends, and the effectiveness of programs to improve safety. The various methods for determining the present and future accident rate for a given highway site are compared and evaluated in this paper, and the conclusion is that at present, there appears to be no advantage in the use of any other data than actual accident data for the determination of the accident potential of a highway site.

Search terms: Accident rates; Accident location; Highway accident potential; Accident risk forecasting

1/5 Statistical Data

HS-009 831 Fld. 1/5

ARIZONA HIGHWAY PATROL MONTHLY STATISTICAL REVIEW JANUARY THRU DECEMBER 1963

Arizona Highway Patrol

[1964] 51p

This contains a monthly analysis of highway patrol activities broken down according to percentage of time spent on each activity in the various state districts. Statistics are presented to show the types of accidents, causes, injuries, total property damage and casualties. Accidents are reported according to the hour of the day and are grouped according to driver age, residence, type of vehicle, weather conditions, road character, and light conditions. The disposition of traffic offender cases and the relationship between enforcement and accident rates are examined.

1/5 Statistical Data (Cont'd.)**HS-009 831 (Cont'd.)**

Search terms: Accident statistics; Fines; Penalties; Convictions; Accident causes; Police traffic services; Road condition caused accidents; Arizona; Accident types; Accident rates; Traffic law violations; Fatality rates; Injury statistics; Time of accidents; Light conditions caused accidents; Law enforcement effect on accident rates

HS-009 832 Fld. 1/5; 5/20**SNOWMOBILE CRASH ANALYSIS**

by William Carlson; Marion Compton

Published in *HIT Lab Reports* p6-8 (Mar 1971)

1 ref

This article presents some initial results of a continuing study of Michigan snowmobile crashes. The study is somewhat biased due to failure to report minor snowmobile crashes. Young male drivers had the highest crash rate. The most frequent accident cause was striking rough terrain or a ditch. Striking fixed objects and wires was more frequent at night.

Search terms: Snowmobile caused injuries; Injury causes; Snowmobiles; Vehicle stability; Ground roughness; Rollover accidents; Injury severity; Night vs day accident risks; Accident statistics; Driver sex; Driver age; Accident types; Male drivers; Young adult drivers; Time of accidents; Vehicle fixed object collisions

2/0 HIGHWAY SAFETY**HS-009 833 Fld. 2/0****NEW HORIZONS**

by J. Stannard Baker; Roy C. Haeusler;

Matthew C. Sielski; James P. Economos; Bernard L. Garmire; R.B. King; Edward Scheidt; Mason Mahin; S.A. Abercrombie; William E. Billings; Paul Edlund

Published in *Traffic Safety* v62 n5 p20-1 (May 1963)

Specialists in key areas of traffic safety pinpoint today's urgent needs and give recommendations as to what is needed to move ahead in the future. Subjects covered in this article are: (1) Traffic accident records; (2) Automotive design; (3) Engineering; (4) Traffic courts; (5) Police traffic supervision; (6) Vehicle inspection; (7) Driver licensing; (8) Laws and ordinances; (9) Education; (10) Organized citizen support; (11) Public information.

Search terms: Accident records; Automobile design; Traffic engineering; Traffic courts; Traffic management; Vehicle inspection; Driver licensing; Traffic laws; Driver education; Public information programs; Highway safety programs; Police traffic services; Community support; Safety education; Safety propaganda

HS-009 834 Fld. 2/0**MICHIGANIAN CHARTS NEW COURSE FOR FEDERAL SAFETY. PT. 2.**

Anonymous

Published in *Motor News* v53 n4 p18-19, 28-31 (Oct 1970)

This is the second of three interviews with Douglas Toms, new head of the National Highway Safety Bureau. Mr. Toms comments on alcohol countermeasures, driver education, driver licensing, and highway safety priorities.

Search terms: Alcohol usage deterrents; Alcohol laws; Driver education evaluation; Driver license laws; Accident causes; High school driving courses; Problem drivers; Driver license suspension; Priorities; Highway safety programs

HS-009 835 Fld. 2/0**THE FUTURE OF HIGHWAY SAFETY**

by John A. Volpe

Department of Transp.

Published in *Journal of Insurance* v31 n5 p15-9 (Sep-Oct 1970)

Aspects of highway safety discussed are restraint systems, crashworthiness, control of drunken drivers, and accident compensation by the insurance industry.

Search terms: Highway safety; Drinking drivers; Insurance industry; Accident compensation; Restraint systems; Crashworthiness; Alcohol usage deterrents; Driver intoxication

HS-009 836 Fld. 2/0**THE FIFTH HORSEMAN - TRAFFIC ACCIDENTS. IT ALL BEGAN 50 YEARS AGO**

by Howard Pyle

Published in *Traffic Safety* v62 n5 p8-9, 41 (May 1963)

On the occasion of the National Safety Council's Golden Anniversary, the author outlines the history of the organized safety movement and the National Safety Council. Traffic safety is now the major challenge.

Search terms: Safety program; Safety organizations; Highway safety

2/4 Design and Construction**HS-009 837 Fld. 2/4****A RUMBLE HEARD FOR HIGHWAY SAFETY**

by Donald F. Kamnikar

Federal Hwy. Administration

Published in *Highway Focus* v3 n1 p35-9 (May 1971)

Drivers can be lulled to boredom or sleep when long straight stretches of express roads and monotonous scenery deprive them of contrast stimuli. Grooved rumble strips were cut into Interstate 80 in southern Wyoming in an area where a number of accidents had been attributed to driver fatigue. Although some motorists stopped on hearing the noise, fearing car trouble, they did so without panic. Locating alerting strips near bridges and interchanges is advocated. No data are available yet on accident preventing effectiveness.

Search terms: Rumble strips; Anti-fatigue devices; Attention lapses; Accident prevention; Driver fatigue; Highway hypnosis; Wyoming

2/1 Breakaway Structures

HS-009 838 Fld. 2/1; 4/7

EFFECT OF VEHICLE COLLISION WITH ALUMINUM ROAD-SIDE SIGN STRUCTURES MOUNTED ON FRANGIBLE BASES

by J. E. Martinez; T. J. Hirsch; Yuce Baskurt; J. J. Jumper

Published in *Highway Research Record* n306 p58-70 (1970)

3 refs

This paper presents the results of the mathematical simulation of vehicle collision with single and dual support aluminum roadside sign structures mounted on frangible bases. The study was performed with the aid of a mathematical model verified by a full-scale crash test and analyzed sign and sign support configurations that are typical of roadside sign structures proposed by the state of Maine. The equations of motion predicting the response of the system were solved numerically and a computer was

used to obtain the results. Some findings of the study reveal that low-speed collisions (15-20 mph) normally cause the support to hit the windshield area of the vehicle; medium-speed collisions (30-45 mph) with the single support structure cause the support to strike the top or trunk area of the vehicle; and medium- and high-speed collisions with the dual support structure cause the post to clear the vehicle.

Search terms: Breakaway sign supports; Sign design; Low speed impact tests; Vehicle sign collisions; Impact tests; Mathematical models; Impact tolerances; Equations of motion; Simulation models; Breaking energy; Aluminum

2/4 Design and Construction

HS-009 839 Fld. 2/4; 4/7

SPACE TECHNOLOGY FOR AUTO-HIGHWAY SAFETY

by M. A. Kaplan; R. J. Henson; R. J. Fay

Published in *Highway Research Record* n306 p25-38 (1970)

9 refs

Presented at HRB 49th annual meeting.

A research team is engaged in the development of impact attenuation systems for highway gores. The achievements to date and future aims are reported. A method for initially screening available energy-absorbing devices is presented. The evaluation of the remaining devices by testing and analysis is discussed. The procedures for inexpensive and flexible testing of attenuation systems using scale-modeling techniques are developed.

Search terms: Energy absorbing systems; Energy absorbing barriers; Scale models; Mathematical analysis; Impact attenuators; Barrier tests; Barrier impact forces

HS-009 840 Fld. 2/4; 5/22

PAVEMENT WEAR DUE TO STUDDED TIRES AND THE ECONOMIC CONSEQUENCES IN ONTARIO

by P. Smith; R. Schonfeld

Published in *Highway Research Record* n331 p54-79 (1970)

10 refs

Presented at the HRB 49th annual meeting.

The wear caused by studded tires has been measured on different pavement surfaces in Ontario by using a simple photographic method to record before-and-after cross-sectional profiles. Results show that, with not more than 20 percent of vehicles using studded tires, substantial wear has occurred during one winter of moderate-to-heavy traffic. Estimates of future pavement wear indicate that a serious problem has to be faced for which no lasting and economical repair or preventive procedures yet exist. Experience in Europe and North America is reviewed in an effort to compare any benefits of studded tires with the widely reported pavement damage they may cause. The alternative courses of action — to restrict the use of studs or allow their continued use — are considered in the light of the findings.

Search terms: Studded tires; Pavement wear; Pavement damage; Ontario; Wear resistance; Wear tests; Highway maintenance; Pavement markings; Bituminous concrete pavements; Damage costs; Concrete pavements

HS-009 841 Fld. 2/4; 5/22

EFFECT OF STUDDED TIRES ON THE DURABILITY OF ROAD SURFACING

by J. Hode Keyser

Montreal Univ. (Canada)

**2/4 Design and Construction
(Cont'd.)****HS-009 841 (Cont'd.)**

Published in *Highway Research Record*
n331 p41-54 (1970)

43 refs

Presented at the HRB 49th annual meeting.

In Sweden, where 60 percent of all vehicles are equipped with studded tires, the pavements are badly deteriorating through wear. The Swedish Road Administration estimates that the cost of wear in 1968-69 amounted to several million dollars. Skid tests made by the Swedish Road Research Institute show that studded tires are effective on icy surfaces near freezing temperature but not so on sanded icy surfaces, packed snow, or very cold ice. Studies made in the laboratory and outdoors on an experimental road track indicate that bituminous mixtures topped with pre-coated bituminous concrete and fine stone-filled sheet mats and portland cement pavements also suffer severe wear. The wear rate however diminishes gradually as the coarse aggregates become exposed on the surface and finally decreases several times in comparison to the initial traffic period. A literature survey and special studies show that studded tires are gaining popularity in the northern part of the United States and Canada. Wear rate of pavements in Montreal by ordinary tires have been determined.

Search terms: Sweden; Studded tires; Pavement wear; Pavement damage; Pavement skid resistance; Wear resistance; Wear tests; Proving ground tests; Icy road conditions; Pavement tests; Materials tests; Canada; Bituminous materials; Laboratory tests

2/8 Police Traffic Services**HS-009 842 Fld. 2/8; 1/3****FLINT'S SELECTIVE ENFORCE-****MENT UNIT PROVES SUCCESSFUL**

by James W. Rutherford

Published in *Traffic Digest and Review*
v19 n4 p9-13 (Apr 1971)

The objectives of selective enforcement are to reduce accidents and improve accident investigation. The Flint (Michigan) Police Division - Traffic Bureau inaugurated its Selective Enforcement Unit July 1, 1969. The results of this program have been excellent to date.

Search terms: Traffic law enforcement; Police traffic services; Accident rates; Injury rates; Accident investigation; Accident prevention; Flint

2/9 Traffic Control**HS-009 843 Fld. 2/9****REVIEW OF SIGNING POLICIES AND PROCEDURES**

by Jack T. Kassel

California Div. of Highways

May 1964 138p 23 refs

Two signing research projects have been undertaken by the Institute of Transportation and Traffic Engineering at the University of California at Los Angeles to provide information as to the most effective sign formats and types of messages. Recommendations of this report include eliminating some freeway names and suspending further signing of others, pending results of current research. Increased stress on the use of route shields is recommended. A system of mileposts for drivers is proposed, to provide an "address system" for freeways and expressways. More driver education on sign types, purposes, and practical limitations is recommended.

Search terms: Highway signs; Sign effectiveness; Direction signs; Sign uniformity; Sign standards; Route signs; Sign design; Freeway driving; Mileposts; Place name signs

HS-009 844 Fld. 2/9**AREA TRAFFIC CONTROL IN GLASGOW. A SUMMARY OF RESULTS FROM FOUR CONTROL SCHEMES**

by Joyce Holroyd; J. A. Hillier

Published in *Traffic Engineering and Control* v11 n5 p220-3 (Sep 1969)

6 refs

The main purpose of the experiment in Glasgow was to find out whether central coordination of traffic signals was worthwhile and, if so, which systems of control produced the greatest benefits. All the 80 signals in the city center could be centrally controlled by an on-line computer, and the experiment was designed to assess existing and unconventional control schemes under standard conditions. Substantial improvements in journey times were produced when all the traffic signals in the city center were linked on a fixed-time basis. Of the two methods used for selecting the signal settings, TRANSYT produced slightly better results than the combination method. The vehicle-actuated flexible progressive system did not prove any better than the fixed-time combination method system during the working day. The other vehicle-responsive system which was tried, EQUISAT, in which the green times are varied so as to maintain an equal degree of saturation on each stage, similarly showed no additional benefits.

Search terms: Glasgow; Traffic flow; Area traffic control; Traffic signal timing; Fixed time traffic signals; Computer controlled signals; Travel time; Traffic signal coordination; TRANSYT (programming language); Green traffic signal timing; Traffic actuated signals

OCTOBER 8, 1971

HIGHWAY SAFETY

HS-009 845 Fld. 2/9

SETTINGS FOR FIXED-CYCLE TRAFFIC SIGNALS

by A. J. Miller

Published in *Australian Road Research Board Proceedings* v2 pt1 p342-65 (1964)

26 refs
Report no. Paper-131

This paper reports the findings of a theoretical study of delays at fixed-cycle traffic signals. Equations are derived for computing the traffic capacity, for determining settings that nearly always clear queues, for settings that minimize delays, and for determining maximum queue lengths. Fixed-cycle traffic signals assume constant traffic flow, and this is never so in practice. Provision should be made for adjusting cycle time to peak traffic flows.

Search terms: Traffic flow; Traffic signal timing; Fixed time traffic signals; Traffic signal delay time; Queueing theory; Traffic capacity; Platoons; Peak hour traffic; Traffic signal cycle length

HS-009 846 Fld. 2/9

TRAFFIC ON UTAH HIGHWAYS, 1970

Utah State Dept. of Highways

Mar 1971 225p

Prepared in cooperation with Federal Highway Administration.

The data contained in this traffic report represent the average daily traffic volumes on road sections of varying lengths on the interstate, primary, federal-aid secondary and state (only) highways of Utah. For comparative purposes, previous average daily traffic volumes are shown for the years: 1937, 1940, 1945, 1950, 1955, 1960, 1965, and 1969.

Search terms: Utah; Traffic volume; Traffic counts; Primary highways; Interstate highway system; Day of week; Highway characteristics; Vehicle characteristics; Traffic surveys; Traffic characteristics; Traffic records; Vehicle mileage; Highway mileage; Traffic data recorders

AVAILABILITY: Corporate author
\$5.00

HS-009 847 Fld. 2/9

EFFECTIVENESS OF SIGN BACKGROUND REFLECTORIZATION

by Lawrence D. Powers

Bureau of Public Roads

Published in *Public Roads* v33 n8 p172-8 (Jun 1965)

2 refs

A study was conducted to compare the brightnesses of signs having different degrees of background reflectorization and to analyze their effect on the ability of drivers to follow a test route to a given destination on controlled-access highways in a suburban area. The results of previous studies by the Bureau of Public Roads have indicated little practical difference in legibility of signs having different degrees of background reflectorization, including no reflectorization. But it was thought possible that the degree of background brightness might affect other sign-effectiveness factors such as detectability or reading time. Data have been compiled on the performance of a total of 150 volunteers, who attempted to follow TEST ROAD signs leading to 18 exit turns. Fifty of these volunteers were tested on each of three successive nights. One-third of the turns were marked with signs having each of three different background materials. The frequency of errors by materials was not statistically significant.

Search terms: Reflectorized signs;

Sign reflectance; Sign recognition; Sign materials; Sign tests; Sign legibility; Sign visibility; Brightness

HS-009 848 Fld. 2/9

THE TRUTH ABOUT SPEED

Anonymous

Published in *American Youth* v5 n5 p12-3 (Sep-Oct 1964)

For every driver there is a very real speed limit that is dictated by a number of conditions: road surface, weather, traffic, roadside hazards, driver experience, and vehicle condition — it is the speed at which the driver has everything under control and has time and space to prevent a sudden change in conditions from turning into an emergency situation.

Search terms: Speed; Road conditions; Driving conditions; Speed limits; Vehicle control; Environmental factors; Driver experience

HS-009 849 Fld. 2/9; 1/4

WRONG-WAY DRIVING ACCIDENTS ARE REDUCED

by Thomas N. Tamburri

Published in *Highway Research Record* n292 p24-50 (1969)

12 refs

Includes discussions by James E. Wilson (National Hwy. Safety Bur.) and Alger F. Malo (Detroit Dept. of Streets and Traffic) and author's closure. Presented at HRB 48th annual meeting.

This report describes the circumstances surrounding wrong-way driving on California freeways and expressways. It provides some insight into the biographical background of the wrong-way driver. Data concerning observed wrong-way driving incidents during three separate

2/9 Traffic Control (Cont'd.)**HS-009 849 (Cont'd.)**

9-month periods were furnished by traffic enforcement officers. In addition, 168 wrong-way drivers were interviewed. The effectiveness of various preventive devices installed on California freeways and expressways was tested. The before and after study method was used, using both incidents of wrong-way driving and wrong-way driving accidents. Reported incidents were also used to measure the efficacy of various off-ramp types in preventing wrong-way entry.

Search terms: California; Wrong way driving; Wrong way signals; Wrong way signs; Accident analysis; Driver errors; Drinking drivers; Driver occupation; Driver records; Freeway driving; Ramps; Driver interviews; Age factor in driving; Sex factors in driving; Driver experience; Visual acuity; Light; Environmental factors; Accident rates

HS-009 850 Fld. 2/9; 4/7**CAR FOLLOWING AND SPECTRAL ANALYSIS**

by John N. Darroch; Richard W. Rothery

Flinders Univ. of South Australia; General Motors Res. Labs.

n.d. 19p 7 refs

An analysis is presented of a linear car-following model using spectral analysis techniques. In particular, it is assumed that the dynamic characteristics of this traffic situation can be described by a weighting function, $h(\tau)$, or equivalently by its Fourier transform, the frequency response function, $H(f)$. A brief description is also given of the role these functions play in the analysis as well as a presentation of their numerical estimates obtained from car-following data.

Search terms: Car following; Mathematical analysis; Spectral analysis; Fourier analysis; Traffic models; Traffic density; Dynamic models

3/0 HUMAN FACTORS**3/1 Alcohol****HS-009 851 Fld. 3/1****AROUND THE WORLD WITH ALCOHOL**

by Robert F. Borkenstein

Published in *Traffic Safety* v71 n5 p8-9, 39-40 (May 1971)

Drinking driver problems in various countries are discussed. Blood alcohol concentration standards vary in different states and in different countries. More severe standards are recommended. The usefulness of random testing to catch drinking drivers is discussed.

Search terms: Alcohol laws; Alcohol usage deterrents; Blood alcohol levels; International factors; Drinking drivers; Driver intoxication

HS-009 852 Fld. 3/1**CUTTING THE HIGHWAY DEATH TOLL. SAFETY CHALLENGE OF 1971**

by William L. Roper

Published in *Highway Patrolman* v34 n12 p4, 20-3, 26-9 (Feb 1971)

The highway death total dropped in 1970, due to safer cars, increased use of seat belts, and other protective devices. But the number one killer on the highway continues to be the drunken driver. Progress has been made in identifying the drunken driver and prosecuting him, but more effective work to reduce the hazards caused by alcoholic drivers is a must and should be the highway safety challenge of 1971.

Search terms: Defective vehicles; Drinking drivers; Automobile safety characteristics; Driver intoxication; Problem drivers; Alcohol usage deterrents

HS-009 853 Fld. 3/1**THE DRUNK DRIVER MAY KILL YOU. WHAT YOU CAN DO TO HELP GET HIM OFF THE ROAD**

Allstate Insurance Co.

n.d. 15p

The nature of the drunk driver problem is outlined. The highway safety standard on alcohol calls for a blood alcohol concentration of 0.10% as presumptive evidence of driver intoxication, the passage of implied consent laws, and alcohol chemical tests of crash victims. Support of this standard is urged.

Search terms: Implied consent laws; Alcohol blood tests; Alcohol breath tests; Alcohol chemical tests; Blood alcohol levels; Drinking drivers; Driver intoxication; Highway safety standards; Community support

3/4 Driver Behavior**HS-009 854 Fld. 3/4****WHAT'S IMPORTANT TO YOUNG DRIVERS?**

by August J. Schulz

Published in *Traffic Safety* v71 n5 p10, 37 (May 1971)

Reprinted from *The Journal of Traffic Safety Education* (Winter 1971).

Little work has been done in preparing new driver attitude scales. A male adolescent driver scale is described, based on attitude statements on driving collected from 547 male adolescents in Wisconsin public high schools. Male and female students participated in discussion-

decision groups of 4 to 6 students. For males, five leading reasons for safe driving were (1) to stay alive, (2) save money on insurance, (3) respect other's lives, (4) fear of losing driver's license, and (5) earn adult's respect. Unsafe driving was explained as (1) need to show off, (2) use of alcohol, (3) showing their own car is better, (4) rush to get some place, (5) proving oneself. Female students expressed similar reasons. The attitude scale did not differentiate between traffic offenders and non-offenders in another group of adolescent males.

Search terms: Male drivers; Driver attitudes; Adolescent drivers; High school drivers; Driver psychological tests; Driver motivation; Traffic law violators; Female drivers; Wisconsin

HS-009 855 Fld. 3/4

PASSING BEHAVIOR ON PUBLIC HIGHWAYS UNDER DAYTIME AND NIGHTTIME CONDITIONS

by Eugene Farber

Published in *Highway Research Record* n292 p11-23 (1969)

Contract CPR-11-2770; FH-11-6145

Presented at the HRB 48th annual meeting.

This study was designed to determine the effect of nighttime visibility conditions on the passing behavior of drivers on two-lane public highways. The experiment was observational in the sense that the drivers whose passing behavior was observed happened along fortuitously and had no idea that they were taking part in an experiment, or that their passing behavior was being observed. The data were obtained only at night, but at the same site and under identical conditions in which data were collected during the day in a previous Franklin Institute contract with the U.S. Bureau of Public Roads. The daytime data from the previous contract are reported along with the nighttime data in the presentation of the results.

Search terms: Passing; Driver performance; Driver behavior; Decision making; Day vs night performance; Overtaking; Oncoming vehicles; Night driving; Sight distances; Night visibility

by R. L. Mellinger

California Univ. ITTE

Apr 1970 182p 8 refs

Report no. PB-196 100; UCLA-ENG-7089

HS-009 856 Fld. 3/4

BEHAVIOR MODIFICATION OF PROBLEM DRIVERS

by Ronald Arthur Kleinknecht

Washington Dept. of Motor Vehicles

Dec 1969 28p 35 refs

Report no. 024

An attempt has been made to establish experimental stimulus control over the driving behavior of a group of male problem drivers in the State of Washington and thereby reduce their rate of traffic violations and accidents. Using behavior modification paradigm, a program was designed with a series of rewards and punishments contingent upon specified behaviors. The results of the study indicated that the particular behavior modification program investigated was not superior to the one presently in existence, but there was evidence that some experimental control was established. Four groups of drivers were studied, one of which was severely restricted in hours of driving. Variables of this group and the three control groups are discussed.

Search terms: Washington; Problem drivers; Driver behavior; Accident rates; Driver improvement; Threat; Penalties; Traffic law violations; Driver attitude measurement; Driver license restrictions; Driver records; Male drivers; Reinforcement (psychology); Driver motivation

The objectives of this study were: to establish a large body of data on long trip drivers including personal and driving history, trip planning habits, and the manner of trip execution; to determine the normative, modal patterns of trip planning and performance; to identify extremes of driver characteristics and trip performance; and to determine the relationships, if any, between these extremes and long trip accidents or known indicators of driving performance such as driving record (accidents and convictions for citations on record with the department of motor vehicles). The report discusses the many factors contributing to accidents on long, over-the-road trips that can be traced back considerably in both time and distance from the instant and site of the accident. The basic conclusion is that the majority of the long distance drivers set reasonable limits. The problem drivers are those who over-extend themselves. It is proposed to make a study identifying these over-extended drivers for law enforcement use.

Search terms: California; Driver behavior; Single vehicle accidents; Trip length; Travel patterns; Questionnaires; Driver characteristics; Driver fatigue; Night driving; Convictions; Radio usage; Multiple vehicle accidents; Driver intoxication; Driver performance; Air conditioning usage; Seat belt usage; Travel time; Driver records; Driver age; Driver sex; Driver interviews; Driver mileage; Driver experience; Marital status; Driver occupation; Passengers

AVAILABILITY: NTIS

HS-009 857 Fld. 3/4

LONG TRIP DRIVING HABITS OF CALIFORNIA DRIVERS: GENERAL FINDINGS. FINAL REPORT

HS-009 858 Fld. 3/4

YOUR TEENAGER AND THE AUTOMOBILE. FOOD FOR

3/4 Driver Behavior (Cont'd.)**HS-009 858 (Cont'd.)****THOUGHT BEFORE HANDING HIM THE KEYS**

by Henry N. Ferguson

Published in *Highway Patrolman* v34 n11 p14-15, 54-6 (Jan 1971)

Much of the high accident rate among teenage drivers is attributed to abuse of the freedom and mobility it offers, and the tendency of young male drivers to show off when behind the wheel of a high-powered car. One solution would be to completely bar the use of automobiles by teenagers but this is not practical. The problem is to convey the idea of moral responsibility for safety to the teenage driver in driver education courses. Although this is difficult, some degree of success is indicated by the fact that insurance companies do reduce the extra premiums charged to "unmarried male drivers under 25 years" if the driver has been school-trained.

Search terms: Young adult drivers; Adolescent drivers; Accident rates; Driver behavior; High school driving courses; Driver attitudes; Male drivers

HS-009 859 Fld. 3/4**THE INFLUENCE OF ADVISORY LETTERS IN CHANGING THE DRIVING BEHAVIOR OF PRIVATE MOTORISTS IN ISRAEL**

by G. Ben-David; I. Lewin; Y. Haliva; N. Tel-Nir

Published in *Accident Analysis and Prevention* v2 p189-200 (1970)

8 refs

The possibility of changing the driving behavior of private motorists by using communication in the form of an advisory letter to improve the drivers' response to traffic signs was studied. The degree of response, correct stopping at a

stop sign, was studied at three intersections; at one a communication involving a degree of fear was used; at the second, communication of a cooperative form was used, and the third intersection served as a control (no communication). The results showed that an advisory letter causes a significant reduction in the error rate compared with the case where no letters were used.

Search terms: Fear; Driver behavior; Warning letters; Driver errors; Careless driving; Traffic signs; Psychological factors; Driver attitude measurement; Israel; Stop signs

HS-009 860 Fld. 3/4**AN HISTORICAL NOTE ON HIGHWAY HYPNOSIS. BRIEF COMMUNICATION**

by Griffith W. Williams; Ronald E. Shor

Published in *Accident Analysis and Prevention* v2 n3 p223-5 (Dec 1970)

20 refs

An early description of highway hypnosis written in 1921 is reprinted. It is supposed to be the first reference to the phenomenon. The description prophetically incorporates many of the features stressed by later writers: the relationship to hypnotic trance; the sleep-inductive features of the roadway; the contribution of fatigue and mental preoccupation.

Search terms: Highway hypnosis; Attention lapses; Driver fatigue; History; Sleep

HS-009 861 Fld. 3/4**EFFECTS OF SLEEP DEPRIVATION AND PROLONGED DRIVING ON A SUBSIDIARY AUDITORY REACTION TIME**

by Hans Olof Lisper; I. Dureman; S. Ericsson; N. G. Karlsson

Published in *Accident Analysis and Prevention* v2 n4 p335-41 (1971)

21 refs

Eleven subjects were employed in an experiment to determine the effect on a subsidiary auditory reaction time of different internal and external factors to three hours of car driving. The conditions were driving in daylight, driving in darkness, and driving after one night without sleep. There was a significant increase of reaction time over the driving duration, but there were no differences among the three conditions. A comparison with two other experiments in the same series points to the apparent significance of monotony of driving as a causal factor in driving-fatigue accidents. Evidence was presented which suggests an inadequacy of the test-driving-retest design in fatigue and driving studies. An intersubject comparison points to both vulnerability to monotony and sleep deprivation as factors in the intersubject variability in sleep deprivation experiments.

Search terms: Driver performance under stress; Driver fatigue; Driver reaction time; Sleep deprivation; Driver tests; Variance analysis; Auditory perception

HS-009 862 Fld. 3/4; 2/9**DRIVER INTERACTIONS AND DELAYS IN FREEWAY TRAFFIC**

by Donald A. Gordon

Department of Transp.

Published in *Highway Research Record* n336 p76-91 (1970)

5 refs

Sponsored by Committee on Road User Characteristics and presented at the 49th Annual Meeting of HRB.

A study was made of the behavior of individual drivers in normal freeway traffic. A car was driven at speeds of 50, 45,

and 40 mph along an interstate highway, causing overtaking drivers to react. Without their awareness, drivers were photographed from a tower and from the vehicle on the road. A driver who approached in a different lane from that of the experimental car, and who was unobstructed, passed without slowing. Obstructed drivers, who changed lanes to pass, also did not slow down. On the basis of the data, it seems likely that the decision to shift is made at 250 ft of separation distance or less. A typical obstructed driver shows a three-phase response. First, the driver moving at his desired pace starts to slow down in anticipation of being blocked. Next, the driver moves to a slightly closer position or matches pace with the car in front. Finally, the driver assumes his original speed and moves ahead of the car in front. Passing drivers and blocked drivers did not slow appreciably.

Search terms: Driver behavior; Freeway driving; Overtaking; Passing; Decision making; Driver behavior research; Driver monitoring; Traffic flow; Lane changing; Traffic surveillance; Photography; Car following

HS-009 863 Fld. 3/4; 3/6; 3/5

PROBLEM DRIVERS: AN EVALUATION OF FOUR TREATMENT PROGRAMS AND THE USE OF QUESTIONNAIRE MATERIAL FOR PREDICTING SUCCESS

by Jean E. Wallace; Alfred Crancer, Jr.
Washington Dept. of Motor Vehicles

Dec 1969 26p 4 refs
Report no. 026

Over 700 drivers who had bad driving records were randomly assigned to four different driver improvement programs. Six months after the end of each program, the records of all participating drivers were analyzed to determine if the driver had maintained a clean record during that time. The relative success /failure rates of the programs were compared. A program which combined

minimum instructional material with progressive easing of license restrictions proved to be the most successful (67 percent success) in the six-month period. The screening questionnaire's 60 items were analyzed to determine their ability to predict success following treatment. The results indicate the relative effectiveness of combining treatment and restrictive measures in programs for driver improvement and the promise of greater success with such programs if methods are developed to assign each problem driver to the type of treatment from which he is most likely to benefit.

Search terms: Problem drivers; Driver improvement; Driver improvement measurement; Driver improvement schools; Questionnaires; Traffic law violators; Driver attitudes; Psychological factors; Chi square test

HS-009 864 Fld. 3/4; 3/12

THE EFFECTS OF SIGHT DISTANCE AND CONTROLLED IMPEDIMENT ON PASSING BEHAVIOR

by Robert S. Hostetter; Edmond L. Seguin

Published in *Highway Research Record* n292 p64-78 (1969)

4 refs
Contract CPR-11-4092

Sponsored by HRB Committee on Operational Effects of Geometrics and presented at the 48th annual meeting.

The purpose of this research was to determine the singular and combined effects of impedance distance, impedance speed, passing sight distance, and traffic volume on driver acceptance of passing opportunities as they occur on rural two-lane highways and the nature of the passing maneuver, itself. The report presents a detailed discussion of the methodology, test sites, instrumentation, experimental procedures, and major results. Passing sight distance was controlled through test site selection,

and traffic volume at the test sites was treated as a sampling variable. The major results indicate that passing sight distance is the predominant variable that influences the decision to pass. An analysis of covariance, in which the effects of traffic volume were controlled, yielded statistically significant effects for impedance speed and the impedance-distance/sight-distance interaction.

Search terms: Rural roads; Passing; Sight distances; Impediment; Speed; Decision making; Driver behavior; Traffic volume; Variance analysis; Two lane roads

3/5 Driver Education

HS-009 865 Fld. 3/5

HIGH-PERFORMANCE DRIVING

by Jerry Goodrich

Published in *Air Force Driver* v5 n1 p1-6 (June 1971)

This is the first in a series of articles about the Bondurant School of High Performance Driving. The school uses a 5-day program, with 30% of the student's time spent in ground school and 70% driving on a speedway course, to train competition road racers. Correct sitting position, arm and hand position, proper shifting and braking techniques are described. Some of the more common learning errors are listed. It is assumed that some of the "pro" driving techniques taught in high performance driving schools would improve highway driver performance.

Search terms: Commercial driving schools; Racing drivers; Driver improvement; Driver performance; Driver education

3/6 Driver Licensing

HS-009 866 Fld. 3/6; 1/5

SOME CHARACTERISTICS OF NORTH CAROLINA ACCIDENT-

3/6 Driver Licensing (Cont'd.)**HS-009 866 (Cont'd.)****INVOLVED DRIVERS RELATIVE TO THE ESTIMATED SPEED PRIOR TO THE ACCIDENT**

Research Triangle Inst.

13 Jan 1971 73p refs

Prepared for the North Carolina Governor's Highway Safety Program.

Rural accidents which occurred in good weather and on dry roads were analyzed. Accident-involved drivers were characterized on the basis of below average, average, and above average speeds. These speeds were 30-39 mph, 50-59 mph, and 70 or more mph respectively. Variables analyzed include driver injury, alcohol involvement, sex, age, vehicle type, vehicle condition, highway type, and time of accident.

Search terms: North Carolina; Accident statistics; Variance analysis; Male drivers; Day of week; Drinking drivers; Accident causes; Driver age; Driver sex; Environmental factors; Injury severity; Rural accidents; Speed studies; Highway characteristics; Vehicle characteristics; Driver intoxication; Time of accidents; Driver characteristics

HS-009 867 Fld. 3/6; 3/4**MODIFYING NEGLIGENT DRIVING BEHAVIOR THROUGH WARNING LETTERS**

by Robin S. McBride; Raymond C. Peck

Published in *Accident Analysis and Prevention* v2 p147-74 (1970)

21 refs

A study was conducted with 18,000 negligent California drivers to evaluate the effectiveness of warning letters in reducing accidents and violations. The study was structured around several key

questions: does the degree of threat and personalized content have any effect on subsequent driving; are experimentally developed letters more effective than standard letters; is a warning letter accompanied by a questionnaire allowing the driver to "sound off" a more effective contact than issuing only a letter; does a follow-up letter acknowledging improved driving record reinforce continued improvement; are certain types of letters more effective for various ages, sex, and marital status groupings; can a warning letter program be justified on a cost/benefit basis. Results strongly supported a warning letter program.

Search terms: Warning letters; Problem drivers; Driver records; Traffic law violators; Driver improvement measurement; Benefit cost analysis; Psychological factors; Threat; Reinforcement (psychology); Questionnaires; Driver marital status; Driver age; Driver sex; California; Driver behavior

3/12 Vision**HS-009 868 Fld. 3/12; 3/4****VELOCITY SENSING — COMPARISON OF FIELD AND LABORATORY METHODS**

by Santo Salvatore

Published in *Highway Research Record* n292 p79-91 (1969)

25 refs

This paper compares the effect of varying the sensory input (visual, auditory, kinesthetic, tactile, and vestibular cues) on the sensing of velocity. The range of velocities was extended to 100 mph. It is concluded that (a) the removal of the force-sense feedback mechanism acts to reduce the ratio of the estimated to the presented or actual range of velocities; (b) there is direct variation of the absolute error with velocity as the range is extended to include high speeds; and (c) sensing of velocity based on peripheral visual stimulation appears to be more resistant to experimental variables, such

as a monotonous environment, fatigue, and the apparent movement produced by an increase of illumination of part of the field, than frontal visual stimulation. A methodological confusion in plotting velocity sensing data when using the methods of estimation and production is pointed out as influencing the description of such data in terms of over-estimation and under-estimation.

Search terms: Velocity perception; Speed; Peripheral vision; Central vision; Motion perception; Variance analysis; Laboratory tests; Field tests

HS-009 869 Fld. 3/12**DRIVER EYE-MOVEMENT PATTERNS UNDER CONDITIONS OF PROLONGED DRIVING AND SLEEP DEPRIVATION**

by N. A. Kaluger; G. L. Smith, Jr.

Published in *Highway Research Record* n336 p92-106 (1970)

18 refs

Presented at the Highway Research Board 49th annual meeting.

This study investigated the changes in eye-movement patterns of three drivers after prolonged driving and sleep deprivation. In the first experimental condition, subjects drove for approximately nine hours with only minor stops for equipment setup and calibration on refueling. Prior to the second 9-hour driving task, the same subjects were deprived of sleep for 24 hours. Eye movements were filmed under open-road conditions (no traffic in the visual field) at three speeds: 40 to 50 mph, 60 to 70 mph, and 75 mph exact velocity maintenance. The eye movements were examined both spatially and temporally, and a new index — pursuit eye movements — was investigated.

Search terms: Eye movements; Sleep deprivation; Driver fatigue; Driving task analysis; Driver performance under stress

OCTOBER 8, 1971

OTHER SAFETY RELATED AREAS

4/0 OTHER SAFETY-RELATED AREAS

4/1 Codes and Laws

HS-009 870 Fld. 4/1

SUBCOMMITTEE ON VEHICLES AND HIGHWAYS. FIRST REPORT

National Com. on Uniform Traf. Laws and Ordinances

26 May 1971 120p

Report of a meeting of the Subcommittee on Vehicles and Highways, Washington, D.C., 4-5 Nov 1970.

The purpose of the sessions described was to make recommendations concerning revisions in the Uniform Vehicle Code. Recommendations deal with 48 subject areas pertaining to vehicle equipment. Seventeen of the recommendations deal with vehicle lighting.

Search terms: Uniform Vehicle Code; Vehicle lighting; Law uniformity

4/3 Cost Effectiveness

HS-009 871 Fld. 4/3

THE SAFETY INDEX: A METHOD OF EVALUATING AND RATING SAFETY BENEFITS

by Thomas N. Tamburri; Richard N. Smith

Published in *Highway Research Record* n332 p28-43 (1970)

16 refs

Presented at the HRB 49th annual meeting.

The California Division of Highways has developed a new tool to evaluate safety improvement projects: the safety index. The safety index represents the percentage of the project's construction plus right-of-way costs that is returned to

motorists as savings in the cost of prevented accidents. It is a safety benefit-cost ratio. It was concluded that although the safety index concept is relatively new, and modifications and refinements are desirable and are being made, this tool has proved helpful in evaluating safety benefits of major construction and spot safety improvement projects. The index is making possible more informed and better decisions in scheduling these projects.

Search terms: Benefit cost analysis; Accident rates; Accident costs; Accident severity; Traffic volume; Highway improvements; Accident prevention; Spot improvement program

4/5 Information Technology

HS-009 872 Fld. 4/5; 1/5

HSRI ACCIDENT DATA BANKS

by Ralph E. Darby, Jr.; Barbara Brown

Published in *HIT Lab Reports* p1-3 (Mar 1971)

In an effort to create a national sample of accident data, the Highway Safety Research Institute has acquired mass accident data from specific Michigan areas and from selected areas of the United States. These data have been built into digital data files for analysis on the University of Michigan's 360/67 computer. Eighteen of these files are described in this article. Detailed descriptions of each file include data origin, acquisition techniques, file size, file composition, and analysis capabilities.

Search terms: Accident statistics; Data acquisition; Data processing; Information systems

4/6 Insurance

HS-009 873 Fld. 4/6

YOU SHOULD BE ABLE TO DRIVE FAULTLESSLY. A COM-

PLATE OVERHAUL OF THE PRESENT SYSTEM OF AUTO INSURANCE IS NECESSARY

by Bob Brown

Published in *Car and Driver* v16 n4 p59-61, 70, 73 (Oct. 1970)

No-fault insurance or a modified form thereof has been proposed as a substitute for liability automobile insurance, and as a solution to the rapidly increasing insurance costs. Opposition to this form of insurance comes from those who benefit most under the present system: insurance agents, claim adjusters, lawyers and their legal staffs, and insurance companies. Three plans that serve as a basis for most of the reforms under consideration are compared: the Keaton-O'Connell Plan, the New York State insurance proposal, and the American Insurance Association personal protection automobile insurance plan.

Search terms: No fault insurance plan; Liability insurance; Insurance industry; Fault; Negligence; Accident compensation; Insurance rates; Injury compensation

4/8 Transportation Systems

HS-009 874 Fld. 4/8

TRANSPORTATION NEEDS OF THE ELDERLY

by Joni K. Markovitz

Published in *Traffic Quarterly* v25 n2 p237-53 (Apr 1971)

Published as part of *The Elderly: Social, Economic and Transportation Needs*, Jun 1970.

Using data available from the 1963 home interview survey conducted by the Tri-State Transportation Commission, a study was conducted for the New York metropolitan area to examine the travel patterns of the elderly. Aspects studied were the intensity of their transportation demand, how well this demand is met,

**4/8 Transportation Systems
(Cont'd.)****HS-009 874 (Cont'd.)**

and whether their mobility can be improved through better transportation facilities, or by bringing the opportunities closer to them, or by some combination of the two. Results show that if the goal for the elderly is "access to opportunities," then the solution is not special transit systems but more optimal land-use, allocation to insure that activities are within easy walking distance of the aged person's home. However, if the goal is to upgrade the elderly's "quality of life," then mere accessibility is not enough; elderly people must be provided with sufficient economic means so that they can afford to take advantage of the available opportunities.

Search terms: Aged drivers; Aged pedestrians; Transportation of aged; Travel patterns; Transportation problems; Sociological factors; Land usage; Urban geography; Population density; Trip frequencies; Trip purpose; Socio-economic data; Residential location; Public transportation usage

5/0 VEHICLE SAFETY**HS-009 875 Fld. 5/0****MICHIGANIAN CHARTS NEW COURSE FOR FEDERAL SAFETY. PT. 1**

National Hwy. Safety Bureau

Published in *Motor News* v53 n3 p18-19, 30 (Sept 1970)

An interview with Douglas Toms, head of the National Highway Safety Bureau, is reported. The new policy of the National Highway Safety Bureau, which places equal priority emphasis on vehicle and driver, is discussed. Vehicle inspection, the experimental safety vehicle, restraint systems, and air bags are briefly discussed.

Search terms: Vehicle inspection; Interviews; Automobile safety standards;

Restraint systems; Air bag restraint systems; Safety cars; Priorities; Vehicle safety; Automobile safety characteristics

oped by applying currently successful principles of limited slip technology. The differential provides limited slip action under adverse driving conditions, but approaches a true conventional differential action during favorable driving conditions. The design is applicable to any wheeled vehicle which uses a differential. In addition, the differential provides a basis for a new full-time, four-wheel drive concept that provides satisfactory all wheel drive on or off highway.

Search terms: Controlled slip differentials; Four wheel drives; Traction; Off the road vehicles; Driving conditions; Torque

AVAILABILITY: SAE**HS-009 878 Fld. 5/4****CRASHING IN SAFETY**

by Karl Ludvigsen

Published in *Motor* (London) v139 n3584 p28-30, 32 (13 Mar 1971)

The Department of Transportation's experimental safety vehicle is described. Reports of various contractors on the design and performance of a safety car are reviewed. The costs of building the prototypes are discussed.

Search terms: Safety cars; Experimental vehicles; Safety design; Automobile design; Automobile costs; Safety device costs

HS-009 879 Fld. 5/4**GENERAL MOTORS OVERSEAS AUTOMATIC TRANSMISSION**

by R. P. Michnay; G. K. Hause

General Motors Corp.; General Motors Strasbourg S.A. (France)

1971 10p 1 ref
Report no. SAE-710613

5/1 Brake Systems**HS-009 876 Fld. 5/1; 5/20****CATERPILLAR'S BRAKESAVER**

by Harold D. Harms; Charles T. Darragh

Published in *Automotive Industries* v144 n8 p61-5 (15 Apr 1971)

An engine brake system developed by Caterpillar is described. The Brake Saver hydraulic retarder is for diesel truck engines. It is based on a principle of hydraulic braking assistance and involves directing oil against a fixed stator in the flywheel housing and dissipating the heat generated—by what is essentially a stalled fluid coupling—through the engine cooling system. The engine will not stall when the vehicle is stopped and the BrakeSaver engaged. System components are described.

Search terms: Brake system design; Brake tests; Hydraulic brakes; Oil cooled brakes; Engine brakes; Brake controls; Engine operating conditions; Diesel engines; Truck brakes

5/4 Design**HS-009 877 Fld. 5/4****AN UNLOADING CONE SPIN-RESISTANT DIFFERENTIAL**

by W. G. Jeakle; D. R. Weilant

Borg-Warner Corp.

1971 7p
Report no. SAE-710611

Presented at SAE mid-year meeting, Montreal, 7-11 Jun 1971.

This paper described a unique limited slip differential concept that was devel-

Presented at SAE mid-year meeting, Montreal, 7-11 Jun 1971.

A new three-speed automatic transmission has been designed and developed for overseas vehicles. A unique arrangement of a Ravigneaux gearset, torque converter, three plate clutches, overrunning clutch, and a band employs new manufacturing techniques. The result is a low cost, lightweight transmission capable of covering a wide range of engine sizes. The requirements of the new transmission were: at least three speeds, flexibility to cover an engine range from 4 cyl, 66 cu. in. to 308 cu. in. V-8, flexibility for installation in left and right drive vehicles, small package size, minimum weight, low cost, and interchangeability of major components. This paper describes the design and manufacture of this new three-speed transmission.

Search terms: Automatic transmissions; Automatic transmission design; Torque converters; Clutches; Automobile manufacturing

AVAILABILITY: SAE

HS-009 880 Fld. 5/4

BIAS BALANCING INTERAXLE DIFFERENTIAL FOR CONSTANT 4-WHEEL DRIVE

by D. E. Hobson; L. J. O'Brien

Dana Corp.

1971 6p 1 ref
Report no. SAE-710616

Presented at SAE mid-year meeting, Montreal, 7-11 Jun 1971.

Limitations of current 4-wheel drive systems for hard surface operation are analyzed. Requirements for off-road mobility are studied and the requirements for a biased interaxle differential are defined from those requirements. The design and test of a biased differential which can be tailored to specific requirements are discussed.

Search terms: Four wheel drives; Traction; Torque; Interaxle differentials

AVAILABILITY: SAE

HS-009 881 Fld. 5/4

POWDER COATINGS — APPLICATION AND RECOVERY TECHNIQUES

by Gunnar Beeth

Ransburg Electro-Coating Corp.

1970 7p
Report no. SAE-710641

Presented at the joint meeting of SAE Mid-Michigan Section and American Chemical Society Midland Section, Midland, Mich., 24 Oct 1970.

Automotive technology is changing. Electrostatic powder coating is a fairly new method for applying finishing coatings. It is gaining acceptability in replacing fluid coatings because it eliminates the problem of disposing of solvent vapors. Today, electrostatic powder coating is feasible for coating nonvisible automotive parts, parts requiring high corrosion protection, evening out rough castings, and finishes requiring surfaces that are soft to the touch. Electrostatic powder coating of exterior automobile finishes is not too far away. This paper outlines the principle of electrostatic powder coating and general parameters in currently available electrostatic powder production equipment.

Search terms: Coatings; Finishes; Films (coatings); Electrostatic powder coatings; Corrosion prevention

AVAILABILITY: SAE

HS-009 882 Fld. 5/4

RESIDUAL STRESSES IN METALS

Society of Automotive Engineers, Inc.

1971 64p 33 refs
Report no. SAE-SP-362

Presented at technical sessions of the SAE Fatigue Design and Evaluation Committee, organized by X-Ray Fatigue Division, Task Group on Residual Stress Data. Includes HS-000 345, HS-008 724, HS-008 742-4, and HS-009 157.

Eight papers are included on residual stresses in steel. Aspects chiefly considered are heat treatment and mechanical working.

Search terms: Residual stress measurement; Steels; Heat treatment; Metal working

AVAILABILITY: SAE

HS-009 883 Fld. 5/4

TRENDS OF VEHICLE DIMENSIONS AND PERFORMANCE CHARACTERISTICS, 1960 THROUGH 1970

by E. E. Seger; R. S. Brink

General Motors Proving Ground

Apr 1971 20p
Report no. 4200

The past decade, model years 1960 through 1970, is highly significant because of the many new developments with respect to the physical and performance characteristics of automobiles. The past decade is unique for a proliferation of new models and the emergence of the two-door hardtop as the most popular model. Of equal importance and interest are the dramatic increases in available horsepower ratings and customer demand for equipment items that add significantly to the safety, comfort, and convenience of modern-day driving. The survey reveals that cars became smaller, lighter, and less powerful from 1960 through 1962. These trends, however, were reversed after that time. A consistent reduction over the years in overall height and center of gravity, in

5/4 Design (Cont'd.)**HS-009 883 (Cont'd.)**

combination with wider tread, achieved important improvements in vehicle stability. From 1962 through 1970, there was a small downward trend in fuel economy. Average eye height above the ground decreased.

Search terms: Vehicle height; Vehicle size; Automobile performance; Brake performance; Acceleration; Sight distances; Vehicle center of gravity; Automobile models; Automobile stability; Automobile power; Fuel economy; Eye location; Automobile safety characteristics; Vehicle length; Vehicle width

HS-009 884 Fld. 5/4**CRASH TESTS**

Anonymous

Published in *Journal of American Insurance* v47 n3 p30-2 (May-Jun 1971)

For the third year, the Insurance Institute for Highway Safety conducted automobile crash tests. Destruction was worse and repair costs higher than ever. Large, intermediate, and small cars were crashed, both front and rear, into solid barriers at 5 mph. Front-to-rear and front-to-side crash tests also were made of identical models at 10 mph. Costs of repairs were much lower for small cars. Dr. Haddon, president of the Institute, stated that cars with crash-resistant bumpers and low-damage exteriors are still not being manufactured.

Search terms: Crashworthiness; Automobile repair costs; Damage costs; Low speed impact tests; Barrier collision tests; Energy absorbing bumpers; Safety design

HS-009 885 Fld. 5/4**THE MENASCO ENERGY ABSORBING UNIT AND ITS APPLICATION TO BUMPER SYSTEMS**

by Giles A. Kendall

Menasco Mfg. Co.

1971 11p 6 refs
Report no. SAE-710536

Presented at SAE mid-year meeting, Montreal, 7-11 Jun 1971.

A compressible solid shock isolator is a combination spring and damper which makes use of a silicone elastomer media to achieve these two functions. It is a candidate for use in energy absorbing bumper systems because of its favorable volume, weight, automatic reset capability, functional efficiency, reliability, and cost. Energy absorbing bumper systems must be designed to accommodate a wide variety of loading conditions. System qualification requires the use of both pendulum and barrier type testing.

Search terms: Energy absorbing bumpers; Barrier collision tests; Pendulum tests; Bumper design; Shock isolators; Test equipment; Spring damping; Elastomers; Silicones

AVAILABILITY: SAE**HS-009 886 Fld. 5/4; 5/6****DESIGNS TO FIGHT SMOG AND DIESEL NOISE**

Anonymous

Published in *Fleet Owner* v66, n5 p200-2 (May 1971)

The causes of diesel engine noise and some designs for a quieter engine are described. Two different concepts for diesel exhaust emissions control, the dual catalyst system and the thermal reactor concepts, are considered.

Search terms: Noise control; Engine noise; Diesel engine exhaust emissions; Exhaust emission control; Dual bed catalyst systems; Thermal reactors; Engine design

HS-009 887 Fld. 5/4; 5/18**TORQUE-BIASING FULL-TIME FOUR-WHEEL DRIVE FOR PASSENGER AND UTILITY VEHICLES**

by K. M. Armantrout; W. M. Dick

Borg-Warner Corp.

1971 8p 2 refs
Report no. SAE-710614

Presented at SAE mid-year meeting, Montreal, 7-11 Jun 1971.

A four-wheel drive transfer case, offering the maximum in mobility and control with minimum driver awareness and response, has been developed. The system is in four-wheel drive mode at all times. It contains a reverse cone differential with friction biasing characteristics for the purpose of relieving drive train wind-up while minimizing wheel breakaway and loss of traction. Design parameters were based on the concept of maximum performance within the limits of technology, mobility at extremes of tractive conditions, control, and cost. Test results are described, including tests on icy pavements.

Search terms: Four wheel drives; Torque; Vehicle handling; Vehicle stability; Vehicle performance; Drive-trains; Transfer cases; Vehicle control; Icy road conditions; Performance tests; Traction; Friction

AVAILABILITY: SAE**5/6 Fuel Systems****HS-009 888 Fld. 5/6****THE EFFECT OF FUEL COMPOSITION, EQUIVALENCE RATIO, AND MIXING TEMPERATURE ON EXHAUST EMISSIONS**

by R. D. Fleming; D. B. Eccleston

Bureau of Mines

1971 11p 14 refs
Report no. SAE-710012

Presented at Automotive Engineering Congress, Detroit, 11-15 Jan 1971.

A single-cylinder research engine was operated on pure hydrocarbons (HC) and simple mixtures of pure hydrocarbons to study the effect of fuel composition, equivalence ratio, and mixture temperature on exhaust emissions. Used as fuel components were hydrocarbons - *n*-pentane, 2-methyl-2-butene, isoctane, and *m*-xylene. Total hydrocarbon emission in terms of moles of exhaust HC/mole of fuel input was lowered by increasing the amount of xylene in the fuel when operating on the fuel-rich side of stoichiometric; total hydrocarbon emission was higher for higher aromatic fuels when air-fuel ratios approached the lean misfire limit; the effect of mixture temperature on hydrocarbon emission was insignificant. 1-Methyl-3-ethylbenzene was observed as a synthesis product of combustion in the exhaust from fuels containing *m*-xylene. With increasing *m*-xylene concentration in the fuel, the yield of 1-methyl-3-ethylbenzene increases, reaches a maximum, and then decreases. The effect of equivalence ratio is to shift this maximum point toward lower aromatic fuels as the fuel-air mixture is leaned out.

Search terms: Vehicle air pollution; Fuel composition; Exhaust emissions; Hydrocarbons; Carbon dioxide; Carbon monoxide; Nitrogen oxides; Fuel mixture temperature; Fuel mixtures; Exhaust emissions measurement; Engine operating conditions; Hydrogen; Aldehydes; Single cylinder engines; Test equipment; Aromatic compounds; Air fuel ratio

AVAILABILITY: SAE

HS-009 889 Fld. 5/6

THOSE NEW GASOLINES: HOW TO PICK THE RIGHT ONE FOR YOUR CAR

by Mort Schultz

Published in *Popular Mechanics* v135 n2 p122-5 (Feb 1971)

No-lead gasoline is supposed to reduce air pollution by extending the life of the experimental catalytic muffler which is the most effective exhaust emission control device yet developed. High compression engines on the majority of cars of 1970 and earlier vintage aren't able to burn unleaded fuel without knocking. Trial-and-error is the only method one can use now to see which octane rating is best for one's car. Some benefits to be derived from using unleaded gasoline now are: elimination of lead fouling of spark plugs, reduction of deposits that build up on valves, pistons, and other engine parts, and reduction of the corrosion of the regular noncatalytic muffler.

Search terms: Lead free gasoline; Leaded gasoline; Octane requirements; Catalytic converters; Exhaust emission control devices; Knock; Engine operating conditions; Engine performance

HS-009 890 Fld. 5/6

A NEW ENGINE FOR THE CLEAN-AIR CAR?

by Glen Lawes

Published in *New Scientist* v47 n708 p10-3 (2 Jul 1970)

The possibility of replacing the internal combustion engine with a different power plant is discussed. It should be possible to meet 1975 exhaust emission standards on hydrocarbons, oxides of nitrogen, and carbon monoxide without adding elaborate devices to the exhaust system. The influence of air fuel ratio and rich or lean fuel mixtures on emissions is discussed. It would be almost impossible to meet 1980 exhaust emissions standards without adding thermal reactors and catalyst beds. A low-pollution gasoline engine will probably be cheaper than its rivals except for diesel engines. The smoke and noise problems of diesel engines are outlined.

Search terms: Exhaust emission standards; Air fuel ratio; Nitrogen oxides; Carbon monoxide; Hydrocarbons; Smoke; Noise; Lean fuel mixtures; Rich fuel mixtures; Dual bed catalyst systems; Thermal reactors; Diesel engine exhaust emissions; Internal combustion engines; Propulsion systems; Exhaust emission control devices

HS-009 891 Fld. 5/6

ENGINE EMISSION CONTROL

by G. Lawrence; J. Wisdom; E. N. Cantwell; I. T. Rosenlund; W. J. Barth; S. W. Ross

Published in *Institution of Mechanical Engineers Proceedings* 1969-70 v184 pt2A n13 p249-294

22 refs

Presented at Automobile Division meeting, Institution of Mechanical Engineers, London, 11 May 1970. Includes HS-009 892 and HS-009 893.

Two papers are presented dealing with emission control by exhaust manifold reactors. Discussion and authors' reply are included.

Search terms: Exhaust emission control devices; Exhaust manifold reactors

HS-009 892 Fld. 5/6

EMISSION CONTROL BY EXHAUST MANIFOLD REACTOR - AN INITIAL STUDY FOR SMALL ENGINES

by G. Lawrence; J. Wisdom

Zenith Carburetter Co. Ltd. (England); E. R. A. Ltd. (England)

Published in HS-009 891 *Institution of Mechanical Engineers Proceedings*, 1969-70 v184 pt2A n13 p249-67

11 refs

5/6 Fuel Systems (Cont'd.)**HS-009 892 (Cont'd.)**

Presented at Automobile Division meeting, Institution of Mechanical Engineers, London, 11-May 1970.

This paper describes the experience gained in a first exercise to investigate the potential ability of exhaust thermal reactors to reduce specific exhaust pollutants from European-sized engines below the control levels likely to be legislated. It is concluded that such systems are both efficient and viable, subject to adequate development, and may become essential if the political trends towards increasingly stringent depollution standards continue. Reactor design is related to engine and vehicle performance and to emission levels. The influence of mixture ratio and ignition changes on the effectiveness of the reactor system is discussed.

Search terms: Engine size effect on exhaust; Engine performance; Exhaust emissions; Exhaust emission control device tests; Exhaust manifold reactors; Thermal reactors; Fuel mixtures; Engine operating conditions; Carburetors; Vehicle performance; Exhaust emission standards; European vehicles; Ignition systems; Fuel consumption

HS-009 893 Fld. 5/6**RECENT DEVELOPMENTS IN EXHAUST MANIFOLD REACTOR SYSTEMS**

by E. N. Cantwell; I. T. Rosenlund; W. J. Barth; S. W. Ross

Du Pont De Nemours (E.I.) and Co.

Published in HS-009 891 *Institution of Mechanical Engineers Proceedings* 1969-70 v184 pt2A n13 p268-85

11 refs

Presented at Automobile Division meeting, Institution of Mechanical Engineers, London, 11 May 1970.

Exhaust emission control systems employing air injection and exhaust manifold reactors in place of conventional exhaust manifolds have been developed to control vehicle emissions of hydrocarbons and carbon monoxide. Low emission levels have been achieved with good driveability, good vehicle performance, and very little loss in fuel economy. Durability tests of a number of exhaust manifold reactor systems indicate that acceptable life in consumer service can be attained. Non-nickel alloy steels developed by specialty steel manufacturers, and based on the iron-chromium-aluminum system, appear to be useful materials of construction for reactors. These alloys, coupled with the now demonstrated simplifications in reactor design, offer one route to lower ultimate costs of these units. The commercial development and application of exhaust manifold reactor systems seems entirely feasible.

Search terms: Aluminum alloys; Chromium alloys; Engine modification; Engine performance; Hydrocarbons; Exhaust emission control devices; Exhaust emission control device tests; Exhaust manifold reactors; Carbon monoxide; Thermal reactors; Air injection reactor systems; Service life; Vehicle performance; Fuel economy; Steels; Acceleration; Materials tests; Wear tests; Durability tests; Oxidation; Iron

HS-009 894 Fld. 5/6**THE CHARACTERIZATION OF ODOR COMPONENTS IN DIESEL EXHAUST GAS**

by R. S. Spindt; G. J. Barnes; J. H. Somers

Gulf Research and Development Co.; General Motors Res. Labs.; Environmental Protection Agency

1971 10p 9 refs
Report no. SAE-710605

Presented at SAE mid-year meeting, Montreal, 7-11 Jun 1971.

Experimental results obtained by Illinois Inst. of Tech. and Arthur D. Little on a project to analyze and identify the odor-relevant compounds present in diesel exhaust gases are summarized. Investigations were confined to a single engine type, operating at one speed and load and burning a single fuel. This was done to minimize the complexity of the analysis and identification of the exhaust odors. Certain fuel fractions were found to be odor relevant. Aromatic hydrocarbons were identified as contributing to exhaust odor. The greatest differences in the results of these investigations were associated with the odor of partially oxidized fuel species.

Search terms: Exhaust composition; Exhaust emission tests; Diesel engine exhaust emissions; Exhaust gases; Exhaust odors; Diesel fuels; Odorants; Aromatic compounds; Unburned fuels

AVAILABILITY: SAE**HS-009 895 Fld. 5/6****A WELL-MIXED THERMAL REACTOR SYSTEM FOR AUTOMOTIVE EMISSION CONTROL**

by Robert J. Lang

Esso Res. and Engineering Co.

1971 9p 5 refs
Report no. SAE-710608

Presented at the SAE mid-year meeting, Montreal, 7-11 Jun 1971.

An experimental well-mixed thermal reactor system called RAM was devised, tested, and applied to several different size research vehicles. Low emissions were obtained because of the thorough mixing and quick warm-up of the system which was aided by flameholders. The study indicates that the RAM concept represents a significant improvement over previously proposed thermal reactor systems. Two versions of RAM were studied. One was operated fuel-rich to minimize NO_x at the expense of fuel economy. The other was operated leaner

and gave better fuel economy but less NO_x control. The best emission results obtained were 3.7 gm/mi. CO, 0.08 hydrocarbons, and 0.72 NO_x . The fuel economy debit was in the range of 17-22%. Better fuel economy, in the range of 10-17% debit, was obtained at NO_x levels of 1.9 gm/mi. Driveability was found to be good. Durability was not tested.

Search terms: Thermal reactors; Fuel economy; Exhaust manifold reactors; Exhaust emission control; Hydrocarbons; Lean full mixtures; Rich fuel mixtures; Nitrogen oxides; Carbon monoxide

AVAILABILITY: SAE

HS-009 896 Fld. 5/6

UNLEADED GASOLINE AND BEYOND

by John Ethridge

Published in *Sports Car Graphic* v11 n6 p34-6, 38, 94 (Jun 1971)

Standards for automobile exhaust emission levels in 1975 will require a 90% reduction of hydrocarbons, carbon monoxide, and nitrogen oxides from present levels. The most promising approaches involves using unleaded gasoline with thermal reactors, exhaust gas recirculation, or catalytic converters. However, problems are cropping up as more experience is gained in using unleaded fuel in engines. At present the automakers are concerned about component durability and reliability and whether they will be able to meet the deadline.

Search terms: Exhaust emission standards; Carbon monoxide; Hydrocarbons; Nitrogen oxides; Lead free gasoline; Thermal reactors; Exhaust gas recirculation; Catalytic converters; Dual bed catalyst systems; Exhaust emission control devices; Lead time

HS-009 897 Fld. 5/6

PROJECTED LUBRICANT RE-

QUIREMENTS OF ENGINES OPERATING WITH LEAD-FREE GASOLINE

by N. E. Galopoulos

General Motors Res. Lab.

1971 10p 47 refs
Report no. SAE-710585

Presented at the SAE mid-year meeting, Montreal, 7-11 Jun 1971.

Future low emissions engines will burn unleaded gasoline. Compared with engines of 1970, future engines will have lower concentrations of NO_x in the blowby gases, and lower blowby flow-rates; however, oil temperatures will probably be unchanged. The consequences of these conditions for engines using high quality (SE) oils at current drain intervals are: virtual elimination of rust, reduction of sludge, no effect on wear and oil thickening, and possible worsening of varnish. Therefore, extension of the drain interval with SE engine oils in the future may be possible, but final decisions will depend on the findings of research in the areas of engine wear and varnish as well as oil thickening.

Search terms: Lead free gasoline; Blowby; Nitrogen oxides; Lubricating oils; Sludge; Engine wear; Corrosion resistance; Engine operating conditions

AVAILABILITY: SAE

HS-009 898 Fld. 5/6

EMISSIONS STUDY OF OXYGEN ENRICHED AIR

by W. J. Wartinbee, Jr.

General Motors Corp.

1971 8p 7 refs
Report no. SAE-710606

Presented at SAE international mid-year meeting, Montreal, 7-11 Jun 1971.

An engine dynamometer study was made to determine the effects of oxygen enriched (up to 39.5 percent oxygen) air-fuel mixtures on exhaust emissions. Compared to operation with lead air-fuel mixtures, the results indicated that hydrocarbon emissions were reduced substantially, carbon monoxide emissions were similar, and oxides of nitrogen emissions increased significantly. Octane requirements and fuel consumption were higher with oxygen enrichment. These emission and performance characteristics are due to the higher peak combustion temperatures associated with oxygen concentrations of greater than the 21 percent normally found in air.

Search terms: Carbon monoxide; Hydrocarbons; Nitrogen oxides; Exhaust emission tests; Air fuel ratio; Fuel combustion; Fuel mixtures; Oxygen; Dynamometers; Lean fuel mixtures; Fuel consumption; Octane requirements; Spark timing

AVAILABILITY: SAE

HS-009 899 Fld. 5/6; 4/4

A SUGGESTED PROGRAM FOR GOVERNMENT AND INDUSTRY IN SOLVING THE AUTOMOTIVE EMISSIONS PROBLEM

by Richard S. Morse

Massachusetts Inst. of Tech.

1968 5p
Report no. SAE-680179

Presented at Automotive Engineering Congress, Detroit, 8-12 Jan 1968.

Air pollution poses a serious threat to this country. In an effort to implement recommendations for the control of automotive air pollution, the more important findings of a government study group are summarized. The development of effective means to infuse new ideas into the automotive industry is discussed.

5/6 Fuel Systems (Cont'd.)**HS-009 899 (Cont'd.)**

Search terms: Air pollution control; Exhaust emission control; Vehicle air pollution; Government industry cooperation

AVAILABILITY: SAE

HS-009 900 Fld. 5/6; 5/4**SOME EFFECTS OF EXPERIMENTAL VEHICLE EMISSION CONTROL SYSTEMS ON ENGINE DEPOSITS AND WEAR**

by Loren G. Pless

General Motors Res. Labs.

1971 14p 20 refs
Report no. SAE-710583

Presented at SAE mid-year meeting, Montreal, 7-11 Jun 1971.

Passenger car tests were conducted to evaluate the effects on deposits and wear of three types of vehicle emissions control systems intended to reduce either evaporative emissions, oxides of nitrogen in the exhaust, or crankcase emissions. These tests used in 1965-1970 model cars, operating with leaded commercial gasolines and 13 different engine oils, in several kinds of service. In engines operated with production crankcase purging rates, crankcase storage increased engine rusting in short-trip service, and increased sludging and valve train wear in low-speed, stop-and-go service. Reducing the crankcase purging rate to overcome hot-starting and driveability problems with crankcase storage caused even larger deposit and wear increases. Engine rusting in short-trip service was increased with exhaust gas recirculation. Doubling the positive crankcase ventilation valve idle air-flow rate greatly reduced engine rusting in short-trip service, and reduced engine deposits and oil oxidation in mixed city-suburban expressway service.

Search terms: Engine deposits; Engine wear; Crankcase deposits; Ex-

haust gas recirculation; Positive crankcase ventilation; Evaporative emission control; Emission tests; Crankcase emissions control; Exhaust emission control; Engine tests; Nitrogen oxides; Wear tests; Trip length; Test equipment

AVAILABILITY: SAE

HS-009 901 Fld. 5/6; 5/15**COMING . . . THE CLEAN AIR CAR**

by William L. Roper

Published in *Highway Patrolman* v35 n2 p4-5, 20-3, 25-7 (Apr 1971)

Steam automobiles, smog control kits for used cars, emission standards, electric cars, and gas turbine cars are discussed. Alternatives to the internal combustion engine may bring smog problems under control.

Search terms: Exhaust emission control devices; Electric automobiles; Gas turbine automobiles; Steam automobiles; Emission standards; Smog control; Internal combustion engines

5/9 Inspection**HS-009 902 Fld. 5/9; 4/7****UNCERTAINTIES IN EVALUATING PERIODIC MOTOR VEHICLE INSPECTION BY DEATH RATES**

by Joseph W. Little

Published in *Accident Analysis and Prevention* v2 n4 p301-13 (1971)

11 refs

Proponents of periodic motor vehicle inspection as an automotive safety measure have dwelled in their advocacy upon the differences in death rates appearing between inspecting states and those that do not inspect. This paper develops an

analysis for observing the variations in death rates within states as PMVI programs are introduced and for comparing them to variations occurring in control states during the same periods. Analyses of data show that death rates decrease no more in states where PMVI is begun than they do in the control states. This suggests that death rate is an improper parameter to use in promoting PMVI and that to avoid unfulfilled expectations its promoters should find more demonstrable arguments in its support.

Search terms: Vehicle inspection; Fatality rates; Fatality differentials; Statistical analysis; Safety program effectiveness

5/10 Lighting Systems**HS-009 903 Fld. 5/10; 3/4****THE EFFECTS OF AUTOMOTIVE REAR-SIGNAL SYSTEM CHARACTERISTICS ON DRIVING PERFORMANCE**

by R. R. Safford; T. H. Rockwell; R. C. Banasik

Published in *Highway Research Record* n336 p1-20 (1970)

14 refs

Presented at HRB 48th annual meeting.

This paper presents the results of several research projects concerned with the evaluation of the effects of automotive rear-signal system characteristics on driving performance. Variables considered in the evaluation included color, size, placement, location, and informational content of the signal systems. Experimental results indicate that almost any change from the current conventional system results in an improvement.

Search terms: Taillamps; Lamp location; Brake lamps; Stop lamps; Rear lamps; Running lamps; Headways; Lighting design; Colored lamps; Vehicle visibility; Brightness; Driver

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behavior; Vehicle lighting; Depth perception; Lamp tests; Road tests

HS-009 904 Fld. 5/10; 5/18

EFFECT OF VEHICULAR ROLL ON POLARIZED HEADLIGHTING

by Walter S. Adams

Published in *Public Roads* v36 n7 p148-57 (Apr 1971)

7 refs

An experimental study to explore the effect of vehicular roll on polarized headlighting performance and driver comfort was conducted. Data obtained in this study showed that polarized headlighting improved target detection distances by 32 percent over high beam headlighting. Moreover, these same data, also used to analyze the relation between detection distances and lateral pavement marking positions (centerline or shoulder), support the use of pavement-edge markings—an additional benefit obtained from the study. The leakage in polarized headlighting systems caused by vehicular roll was shown to have an insignificant effect on the ability of drivers to detect pavement markings at night, adding further support to the logic of using polarized headlighting systems. Neither high intensity polarized headlighting nor conventional high beam headlighting was significantly affected by vehicular roll.

Search terms: Polarized headlamps; Glare reduction; Roll; Distance perception; Driver reaction distance; Vehicle stability; High beamed headlamps; Variance analysis; Headlamp glare; Pavement edge markings; Sight distances; Centerline markings; Target detection

5/15 Propulsion Systems

HS-009 905 Fld. 5/15

STEAM ENGINES AGAIN? YES — BUT WITH A NEW APPROACH

Anonymous

Published in *Automotive Engineering* v78 n10 p36-41 (Oct 1970)

A prototype rotary steam expander, using the principle of the sliding vane pump in reverse, develops 76% of the theoretical maximum power. The steam generator burns gaseous fuel cleanly and efficiently on a ceramic grate. The internal combustion form of the steam expander has a unique thermodynamic cycle in that it features a greater expansion ratio than the compression ratio. This steam engine, called the Hinckley-Beloit-Hornbostel engine, is compared with the General Motors SE-101 steam car's engine. Efficiency should be high and exhaust emissions low.

Search terms: Steam engines; Exhaust emissions; Rotary steam engines; Compression ratio; Generators; Engine performance

HS-009 906 Fld. 5/15

SIMPLIFIED CONTROL FOR BATTERY CARS

by B. J. Prigmore; C. R. Ellum

Published in *Automotive Design Engineering* v10 p32-4 (Jan 1971)

3 refs

The elegance of electronic control may increase the range of a battery car used for long periods in dense city traffic. Pending quantity production, however, the relative complexity of such systems renders them unnecessary luxuries for a car which performs most of its service in suburbs. For such a car, two-voltage rheostatic control, which is simple to provide and has several advantages over single-voltage rheostatic control, should be adequate. The purpose of this article is to explain and describe such a scheme and to record the performance of an experimental car so equipped. A change of gear ratio would bring significant improvement on stop-start runs. An increase of about 20% in the ratio motor-

speed/road-speed would give a higher initial acceleration for the same motor current than at present; and by use of motor field control, would allow acceleration to normal operating speeds. With lower resistance loss than at present, the range should be somewhat increased; and with a slight reduction of effective motor current and significant increase in average motor speed, the motor will be less severely overloaded.

Search terms: Electric automobile design; Performance tests; Energy consumption; Electric automobile range; Engine speeds; Acceleration onset rate; Batteries

5/17 Safety Defect Control

HS-009 907 Fld. 5/17; 5/11

DEFECTS IN AUTOMOBILES AND THE QUALITY OF REPAIR WORK

Automobile Club of Missouri

May 1969 61p

Presented to the Subcommittee on Antitrust and Monopoly of the Senate Judiciary Committee.

In 1967 the Auto Club of Missouri opened an automobile diagnostic center. The center carries out no repairs, makes no estimates of repair costs, and offers no recommendations as to the choice of repairer. The diagnostic center services are: (1) complete diagnostic inspection; (2) separate component checks; (3) inspections to comply with the Missouri inspection law; (4) a recheck of components or which have been repaired (5) a written report for the customer. From surveys of cars and repairs examined, it was concluded that the majority of cars had at least one potentially dangerous defect; that about twice as many five-year-old cars had a dangerous defect as new cars; that garage work involving simple replacement of components was better done than adjustments; that no firm conclusion could be drawn on which type of garage does the best work.

**5/17 Safety Defect Control
(Cont'd.)**
HS-009 907 (Cont'd.)

Search terms: Diagnostic centers; Vehicle inspection; Defective vehicles; Vehicle maintenance; Vehicle age; Automobile defects; Defect correction; Repair industry; Missouri

5/18 Steering Control System

HS-009 908 Fld. 5/18

DATA INDICATE LOWER STEER RATIO PROMOTES BETTER EMERGENCY ACTION

by William Flanagan

Published in *Automotive Engineering*
v79 n4 p30-2 (Apr 1971)

Road tests of vehicles using different power-assisted steering gear ratios indicate that drivers perform better with lower ratios, even though they prefer the ease of high ratios.

Search terms: Steering gear ratios; Power steering systems; Variable ratio gears; Steering; Driver performance; Road tests; Driver emergency responses

HS-009 909 Fld. 5/18; 5/4

GKN FERGUSON FORMULA ALL-WHEEL CONTROL SYSTEM

by O. Webb

G.K.N. Birfield Transmissions Ltd.

1971 15p 3 refs
Report no. SAE-710615

Presented at SAE mid-year meeting, Montreal, 7-11 Jun 1971.

Preventing loss of vehicle control under drive conditions is analogous to, and as important as, the retention of vehicle control under emergency braking. Loss of control under drive conditions frequently leads to panic braking, which

only aggravates an already dangerous situation. A four-wheel system for passenger cars is described, having as its special aim greatly improved controllability under all road surface conditions. Reasons are given for splitting the torque unequally between the front and rear axles, and for employing two spin control clutches geared in parallel to the center differential in such a manner as to modify the basic torque split.

Search terms: Four wheel drivers; Vehicle control; Differentials; Four wheel drive automobiles; Torque; Differential design

AVAILABILITY: SAE

5/20 Trucks and Trailers

HS-009 910 Fld. 5/20; 5/4

THE TYPES OF VEHICLES WHICH HAVE EXCESSIVE AXLE LOADS

by J. W. Grainger

England Road Res. Lab.

1971 24p 5 refs
Report no. RRL-LR-380

Under the Construction and Use Regulations, 1969, the maximum axle load permitted on commercial vehicles varies from 9 to 11 tons depending on the type of vehicle and the arrangement of its axles and wheels. However, at the sites where the Laboratory has full scale pavement design experiments, a significant number of vehicles have axle loads exceeding these limits. To see what types of vehicle were being overloaded, each electronic weigh-bridge was used to trigger a camera and photograph any moving vehicle having an axle load exceeding 12.5 tons (12.7 Mg.). The measurements were made at eleven of the experimental sites and a total of about 6,000 vehicles was photographed. Of these, about half were two-axled trucks with dual tired wheels at each end of the rear axle, about one-third were articulated vehicles with dual tired wheels at

each end of the single rear axle of the trailer, about an eighth were articulated vehicles with four wheels spaced at intervals along the rear axle of the trailer. Very few vehicles with tandem axles or other axle configurations were recorded.

Search terms: Great Britain; Axle loads; Trucks; Articulated vehicles; Vehicle weight limits; Loads (forces); Weight limits

HS-009 911 Fld. 5/20; 5/4

THE FORMATION OF TRUCK SPRAY ON WET ROADS. FINAL REPORT

by Irwin O. Kamm; Gilbert A. Wray; Richard G. Kolb

Stevens Inst. of Tech.

Apr 1970 119p 12 refs
Report no. R-1431

This report contains the results of a four-phase project to produce information useful in the alleviation of the truck spray and mist problem. A literature search, laboratory experiments, and two field-test phases produced experimental fenders which are very effective in reducing the mist emitted by a tractor-trailer operating in heavy rain at highway speeds. Recommendations for future research are presented.

Search terms: Fender design; Splash control; Wet road conditions; Tire tread patterns; Reduced visibility; Mudflaps; Laboratory tests; Field tests; Truck tires; Mathematical analysis

HS-009 912 Fld. 5/20; 5/18

PRINCIPLES AND DESIGN OF MECHANICAL TRUCK TRANSMISSIONS

by Charles M. Perkins

Eaton Yale and Towne, Inc.

Jan 1971 20p 6 refs
Report no. SAE-710288; SAE-SP-363

Seventeenth L. Ray Buckendale Lecture.

The paper discusses the function of the diesel truck transmission and gives formulae for the determination of the correct combination of speed and torque necessary to overcome resistance to the motion of the vehicle. Ratio steps are determined and arranged and design details are given. The capacities of gears, bearings, and multiple countershaft designs are calculated. Ratios for transmission types and shifting are determined.

Search terms: Torque; Shift level sequence; Truck performance; Bearings; Loads (forces); Gears; Mathematical analysis; Diesel engines; Transmissions; Engine speeds; Motion

AVAILABILITY: SAE

5/22 Wheel Systems

HS-009 913 Fld. 5/22; 1/3

“MAG” WHEELS

by W. S. Rouse

North Carolina Univ. Hwy. Safety Res. Center

Jul 1969 12p
Report no. HSRC-Bull-12

A crash is reported in which three of four light weight wheels, popularly known as “mag” wheels, broke loose from a car, and the fourth wheel was severely cracked. The question is raised as to whether breakage of this type of wheel is a common occurrence, or was the breakage merely a freak event. Various implications for safety are discussed. To gain more information to illuminate this single case, a request is made for data from other researchers on

“mag” wheel performance. In the crash in question, wheel failure occurred after the vehicle was first struck on the side by another vehicle and probably did not increase the seriousness of the accident nor result in injury to the driver. The possibility is raised, however, that similar wheel failure could aggravate a situation or possibly even be the cause of an accident.

Search terms: Wheel failures; Side impact collisions; Wheel performance; Accident case reports

HS-009 914 Fld. 5/22; 1/3; 4/3

A STUDY OF RELATIONSHIPS BETWEEN TIRE TREAD DEPTH AND THE LIKELIHOOD OF ACCIDENT INVOLVEMENT. LEVEL 1 REPORT

Highway Safety Foundation

Mar 1971 32p 3 refs

Prepared in cooperation with Ohio State Highway Patrol.

The principal objectives of this study, based on 2,717 accidents, were to determine if and how tire wear affects the odds for accident involvement and what tread depth, if any, should be employed as a legal minimum on the basis of economic considerations. A secondary objective was to determine what portion of accident experience and associated costs is related to intrinsic or outright tire failure. Conclusions are that an inverse relationship does exist between tire tread depth and the likelihood of accident involvement, and that a legal minimum tread depth is desirable. Furthermore, the study identifies 4/32" as the value most appropriate for this purpose. The inverse relationship and economic analysis also show the benefits to be derived from more intensive enforcement of legal minimum tread depth requirements.

Search terms: Tire tread depths; Tire standards; Tire failure caused acci-

dents; Tire failures; Benefit cost analysis; Accident risks; Accident studies; Wet road conditions; Dry road conditions; Accident costs

5/23 Windshield-Related Systems

HS-009 915 Fld. 5/23

WINDSHIELD WIPERS

by Jack Steele

Published in *Fleet Owner* v66 n5 p59-63, 160 (May 1971)

Most of the difficulties experienced with windshield wipers seem to involve not the basic wiper motor failure but failures of small parts of the assembly. Some of the advantages and disadvantages of electric wipers, the commonest type, are discussed, with maintenance and repair suggestions for specific problems. Several types of air wipers, which require the presence of a compressed air supply or the vehicle, are shown and their performance given. Windshield washers and washing fluids are briefly discussed. Hydraulic wipers are mentioned.

Search terms: Windshield washers; Windshield wipers; Windshield wiper design; Trucks

NHTSA DOCUMENTS

NHTSA Contractors Reports

HS-800 475 Fld. 5/4; 5/18

PARAMETRIC STUDY OF VEHICLE DYNAMIC RESPONSE. VOL 1. PROGRAM SUMMARY. FINAL REPORT

by Cory Gray

Digitek Corp.

**NHTSA Contractors Report
(Cont'd.)****HS-800 475 (Cont'd.)**

Nov 1970 90p 3 refs
Contract FH-11-7315
Report no. DARD-2-vol-1

An automobile in the class of the experimental safety vehicle family sedan was subjected to a series of accident avoidance tests to evaluate the effects of vehicle parameter changes on performance. Weight and suspension parameter variations were studied with respect to braking, steering, handling, overturning immunity, and engine output capabilities. This volume presents a review of the methodology and a summary of the results.

Search terms: Experimental automobiles; Safety cars; Automobile stability; Accident avoidance tests; Brake tests; Steering tests; Lateral acceleration; Engine performance; Rollover tests; Performance tests; Automobile handling; Yaw; Suspension systems; Vehicle weight; Brake systems; Parking brakes; Crosswind; Weight to power ratio; Automobile performance; Proving ground tests

AVAILABILITY: NTIS

HS-800 476 Fld. 5/4; 5/18**PARAMETRIC STUDY OF VEHICLE DYNAMIC RESPONSE. VOL. 2. APPENDICES. FINAL REPORT**

by Cory Gray

Digitek Corp.

Nov 1970 334p
Contract FH-11-7315
Report no. DARD-2-vol-2

An automobile in the class of the experimental safety vehicle family sedan was subjected to a series of accident avoidance tests to evaluate the effects of vehicle parameter changes on performance. Weight and suspension parameter variations were studied with respect to

braking, steering, handling, overturning immunity, and engine output capabilities. This volume contains four appendices which describe the test vehicle, the test facilities, and the test plans; and presents all of the reduced data in the form of tables.

Search terms: Experimental automobiles; Safety cars; Automobile handling; Accident avoidance tests; Brake tests; Test facilities; Test equipment; Instrumentation; Steering tests; Lateral acceleration; Engine performance; Automobile performance; Automobile stability; Performance tests; Proving ground tests

AVAILABILITY: NTIS

HS-800 477 Fld. 5/14**PRELIMINARY VEHICLE TESTS
— INFLATABLE OCCUPANT RESTRAINT SYSTEMS. VOL. 1 —
EXECUTIVE SUMMARY**

by James F. Martin; David J. Romeo

Cornell Aeronautical Lab., Inc.

Mar 1971 174p 10 refs
Contract FH-11-7621
Report no. CAL-YB-2990-K-1

Search terms: Barrier collision tests; Anthropometric dummies; Air bag restraint systems; Acceleration tolerances; Vehicle vehicle impact tests; Occupant protection; Instrumented vehicles; Automobile models; Human body size; Pole impact tests

AVAILABILITY: NTIS

HS-800 478 Fld. 5/14**PRELIMINARY VEHICLE TESTS
— INFLATABLE OCCUPANT RESTRAINT SYSTEMS. VOL. 2 —
FINAL PROGRAM REPORT**

by James F. Martin; David J. Romeo

Cornell Aeronautical Lab., Inc.

Mar 1971 174p 10 refs
Contract FH-11-7621
Report no. CAL-YB-2990-K-2

Report for 30 Jun 1970-31 Mar 1971.

A test program was conducted in which 12 full-scale automobiles were crashed under controlled conditions to provide detailed performance data on inflatable occupant restraint systems (IORS). Both domestic and imported vehicles were used covering the range of size from sub-compact to standard. Flat faced barrier, pole, and car-to-car crash modes were included. Various arrangements of anthropometric dummies ranging in size from a 3-year old child to a 95th percentile male were used in the vehicles. Both the vehicles and the simulated occupants were highly instrumented and extensive high-speed movies were taken. Crash test procedures were developed and an evaluation of currently available IORS was made. This volume constitutes the detailed final report on the project.

Search terms: Anthropometric dummies; Barrier collision tests; Air bag restraint systems; Head on impact tests; Acceleration tolerances; Air bag inflation pressure; Test equipment;

Pole impact tests; Vehicle vehicle impact tests; Barrier impact forces; Occupant protection; Instrumented vehicles; Vehicle size; Crashworthiness; Sensors; Automobile models; Human body size

AVAILABILITY: NTIS

HS-800 479 Fld. 5/14

**PRELIMINARY VEHICLE TESTS
— INFLATABLE OCCUPANT RESTRAINT SYSTEMS. VOL. 2 —
FINAL PROGRAM REPORT —
APPENDIX A.**

Cornell Aeronautical Lab., Inc.

Mar 1971 166p
Contract FH-11-7621
Report no. CAL-YB-2990-K-2A

Report for 30 Jun 1970-31 Mar 1971.

A test program was conducted in which 12 full-scale automobiles were crashed under controlled conditions to provide detailed performance data on inflatable occupant restraint systems (IORS). Both domestic and imported vehicles were used covering the range of size from sub-compact to standard. Flat faced barrier, pole, and car-to-car crash modes were included. Various arrangements of anthropometric dummies ranging in size from a 3-year old child to a 95th percentile male were used in the vehicles. Both the vehicles and the simulated occupants were highly instrumented, and extensive high-speed movies were taken. Crash test procedures were developed and an evaluation of currently available IORS was made. This appendix contains copies of transcriptions of tape data onto a direct writing oscilloscope. The IORS program test number, and the filter corner frequency used in going from tape to direct writing recorder are shown with each figure.

Search terms: Anthropometric dummies; Barrier collision tests; Air bag restraint systems; Head on impact tests; Acceleration; Human body size;

Air bag inflation pressure; Leg impact tolerances; Chest acceleration tolerances; Pelvic acceleration tolerances; High speed photography; Crashworthiness; Occupant protection; Instrumented vehicles; Automobile models; Head acceleration tolerances; Pole impact tests; Vehicle vehicle impact tests

AVAILABILITY: NTIS

HS-800 480 Fld. 5/14

**PRELIMINARY VEHICLE TESTS
— INFLATABLE OCCUPANT RESTRAINT SYSTEMS. VOL. 2 —
FINAL PROGRAM REPORT —
APPENDIX B**

Cornell Aeronautical Lab., Inc.

Mar 1971 143p
Contract FH-11-7621
Report no. CAL-YB-2990-K-2B

Report for 30 Jun 1970-31 Mar 1971.

A test program was conducted in which 12 full-scale automobiles were crashed under controlled conditions to provide detailed performance data on inflatable occupant restraint systems (IORS). Both domestic and imported vehicles were used covering the range of size from sub-compact to standard. Flat faced barrier, pole, and car-to-car crash modes were included. Various arrangements of anthropometric dummies ranging in size from a 3-year old child to a 95th percentile male were used in the vehicles. Both the vehicles and the simulated occupants were highly instrumented and extensive high-speed movies were taken. Crash test procedures were developed and an evaluation of currently available IORS was made. This appendix contains photographs of all of the test vehicles used in the program, both pre-crash and post-crash.

Search terms: Anthropometric dummies; Barrier collision tests; Air bag restraint systems; Head on impact tests; Automobile models; Pole impact

tests; Vehicle vehicle impact tests; Human body size; Crashworthiness; Occupant protection; Instrumented vehicles; Precrash phase; Postcrash phase; Photographs

AVAILABILITY: NTIS

HS-800 481 Fld. 5/14

**PRELIMINARY VEHICLE TESTS
— INFLATABLE OCCUPANT RESTRAINT SYSTEMS. VOL. 3 —
TEST PROCEDURES AND INSTRUMENTATION**

by James F. Martin; David J. Romeo

Cornell Aeronautical Lab., Inc.

Mar 1971 156p
Contract FH-11-7621
Report no. CAL-YB-2990-K-3

Report for 30 Jun 1970-31 Mar 1971.

A test program was conducted in which 12 full-scale automobiles were crashed under controlled conditions to provide detailed performance data on inflatable occupant restraint systems (IORS). Both domestic and imported vehicles were used covering the range of size from sub-compact to standard. Flat faced barrier, pole, and car-to-car crash modes were included. Various arrangements of anthropometric dummies ranging in size from a 3-year old child to a 95th percentile male were used in the vehicles. Both the vehicles and the simulated occupants were highly instrumented, and extensive high-speed movies were taken. Crash test procedures were developed and an evaluation of currently available IORS was made. This volume reports in some detail the test procedures, data acquisition techniques, and instrumentation used to carry out the objectives of the program. A brief procedural guide to IORS testing in general is included. It is intended to provide guidelines for IORS test work and not to be construed as a manual.

**NHTSA Contractors Report
(Cont'd.)**

HS-800 481 (Cont'd.)

Search terms: Anthropometric dummies; Barrier collision tests; Air bag restraint systems; Head on impact tests; Acceleration tolerances; Checklists; Automobile models; Pole impact tests; Vehicle vehicle impact tests; Human body size; Crashworthiness; Occupant protection; Test equipment; Test facilities; Instrumented vehicles; Data acquisition; Data reduction; Photography

AVAILABILITY: NTIS

**NHTSA Staff Speeches,
Papers, etc.**

3/1 Alcohol

HS-810 164 Fld. 3/1

**VIOLENCE BY VEHICLE: AN
AMERICAN TRAGEDY**

by Robert B. Voas

National Hwy. Traf. Safety Administration

[1970] 30p 24 refs

The role of alcohol in fatal accidents as well as crime is examined. Recognizing that not all drivers who drink contribute to accidents, the Department of Trans-

portation's alcohol countermeasures program is concentrating on the problem drinkers that drivers, whose blood alcohol concentrations are often 0.10% or more, and the social drinker who occasionally drinks to excess. A do-it-yourself breath tester might help, but the problem drinker will have to be prevented from driving by some other means. Some effective means of rehabilitating problem drinkers is needed, and the national alcohol countermeasures effort proposes to find it.

Search terms: Accident causes; Drinking drivers; Alcohol breath tests; Blood alcohol levels; Driver rehabilitation; Driver intoxication; Alcohol usage deterrents; Problem drivers; Violence; Crime; Suicide by vehicle; Alcoholism



executive summary

ASYNOPSIS OF A RECENTLY RELEASED NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION RESEARCH REPORT

1971 ANNUAL REPORT, DEPARTMENT OF MOTOR VEHICLES, DISTRICT OF COLUMBIA GOVERNMENT

The objectives of this contract with the District of Columbia Government are to establish a methodology and a means whereby State Motor Vehicle Inspection Programs can, with Federal aid, provide support to the National Highway Traffic Safety Administration in its compliance activities. The project team, in the course of the study, will examine the efficacy of the Motor Vehicle Safety Defect Recall Campaigns through the operation of the motor vehicle inspection process. It will also provide a basis for related studies of the involvement of vehicles in accidents.

Contract FH-11-7191
Department of Motor Vehicles
District of Columbia Government
301 C Street, N.W.
Washington, D.C. 20001
DOT/HS-800 525

Total Funds Provided: \$2,411,000.00
Contract Start: 6/5/69
To Be Completed: 6/30/74

General Remarks

This review synthesizes the 1971 Annual Report of the District of Columbia Government that covers the activities and progress of its pilot State Motor Vehicle Inspection Program through the second year of a five year project. First phase findings from the 1970 Annual Report are included in this synopsis under the heading "Major Findings, Conclusions, and Recommendations To Date" so that the reader will be kept currently informed on the progress made up to this point in the program.

There were no deviations from the original planning except for minor changes to provide the operations with the maximum flexibility to permit the enhancement of the project with new methods and equipment that can be utilized in providing a variety of specialized services in the field of vehicle inspection and to serve the research needs of the National Highway Traffic Safety Administration. Among the new areas of development is a massive Information Retrieval System (IRS) operation in a real-time, on-line environment. It contains data not only on vehicle registration and inspection but data on vehicles involved in manufacturers' Safety Defect Recall Campaigns and on vehicles involved in accidents. Information on the

IRS is described in detail in the report. The utilization of dynamic testing equipment in a volume inspection program was also accomplished. This has provided the project with the capability of developing techniques and procedures for using this type of equipment in an inspection program. In addition to the original contractual requirements for this project, the District of Columbia Department Motor Vehicles is testing vehicle exhaust emission. This was developed through a coordinated arrangement with the Department of Health, Education and Welfare.

The method to achieve the objectives is to utilize an on-going Motor Vehicle Inspection Program in a pilot demonstration for determining compliance achieved in correcting defects identified in the Motor Vehicle Safety Defect Recall Campaigns. The demonstration will involve a universe of motor vehicles, all of which are subject to an annual inspection within a specific jurisdiction. The inspection procedures will be currently updated and improve to include the latest diagnostic equipment and an on-line, real-time information retrieval system, the IRS mentioned earlier. This enables a Motor Vehicle Inspection Team to make an immediate correlation between the vehicle presented for inspection and any related defect recall campaign. The IRS will enable the automation of the

entire inspection record keeping system and store motor vehicle registration data as well as accident records.

The main effort of the initial phase of the pilot demonstration will be the development and refinement of techniques and practices to enable motor vehicle inspection programs in any State to incorporate the procedures necessary to link defect notification to the inspection process. A parallel goal is to learn how best to assist States to make the transition to the most modern inspection procedures without incurring the heavy costs of development and testing.

MAJOR FINDINGS, CONCLUSIONS AND RECOMMENDATIONS TO DATE

- The problem of establishing a uniform identification file for vehicles involved in Safety Defect Recall Campaigns is compounded due to the lack of uniformity of numbering between the various manufacturers. A standard system should be developed and adopted by the manufacturers that would greatly enhance the success of any identification system on a national basis.
 - The technical feasibility of using compacted vehicle identification numbers (VIN's), thus achieving substantial savings in costly core and peripheral storage requirements, and retaining the capability to successfully retrieve a vehicle record for any given vehicle involved in one or more safety defect recall campaigns has been proven. However, non-uniformity of VIN structures utilized by vehicle manufacturers does, perforce, require special computer programming efforts to compact each manufacturer's VIN structure for purposes of storage in the on-line data base.
 - At the present time, 847,349 compacted VIN's are in the on-line data base, representing a total of 11,201,544 VIN's, a savings of 138,841,280 bytes of storage, or, about five 2314 disc parks at an annual cost savings of approximately \$37,000.
- Special vehicle inspection data sampling tasks can be accomplished during the normal inspection process with no major disruption in the routine work flow and with little inconvenience to the public.
- The total project has the potential of providing NHTSA with valuable management decision-making information for application on a recurring

basis and for projected planning and programming purposes. A wealth of information presently exists in raw data form. NHTSA management needs dictate the necessity to refine the raw data into meaningful, decision-making information.

○ A vital need exists to collect data on various vehicle components relating to safe operation of vehicles-in-use. The collection of such data can best be satisfied in a controlled inspection day-to-day live environment, as is now utilized by D.C. DMV on this project.

○ A real need exists for uniform and objective motor vehicle inspection programs to be adopted by all jurisdictions. Variances in criteria for inspection elements are far too prevalent and up-dated performance standards are a necessity. For example, when vehicles-in-use standards are promulgated there is a quite strong probability that States will be seeking guidance from NHTSA relevant to test equipment. Logically, such standards should be promulgated, at least in part, based on equipment testing data accumulated in a live controlled inspection environment. Experience to date, on this project, with installed routine inspection equipment as well as new dynamic testing equipment has provided several factors to be considered in the area of equipments, not merely in terms of performance but also in terms of general specifications. A few factors to be considered for guidance to States when selecting equipment for motor vehicle inspection programs are:

- Comparative analyses and evaluations of different manufacturers' equipments and capabilities.
- Equipment costs including installation.
- Reliability of resultant inspection data.
- Capability to conduct multiple identical tests on a vehicle and obtain identical data readings on each test.
- Elimination, insofar as possible, of the human factor relevant to judgments on the part of inspectors.
- Selection of current state-of-the-art equipments from well established, reputable manufacturers to preclude near-term obsolescence.
- Ease of equipment operation to minimize special training of inspectors.

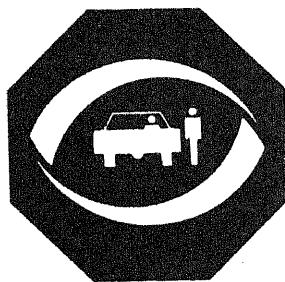
Ensure that all gauges, indicators, dials, etc., which depict inspection data, are easily visible to the inspectors and the public.

- A comprehensive management information system (MIS) be developed, based on information now and to be contained in the on-line data base, to provide NHTSA management with meaningful decision-making information for use in present and projected planning and programming purposes. The MIS is now in the conceptual stage and will be presented to NHTSA for consideration subsequent to formulation of the system plan.
- Expand the project's present inspection lanes and data collection process to provide the capability of gathering valuable data to satisfy NHTSA's needs for information on various vehicle components related to safe operation of vehicles-in-use.
- Expand, develop and upgrade the project's D.C. DMV special motor vehicle inspection lanes with state-of-the-art test equipment and techniques, for updating ANSI D7.1 (1968) as the minimum standard for national motor vehicle inspection programs.

The Contract Manager has certified that the contractor's work on this phase of the contract has been satisfactorily completed and that all contractual obligations have been met.

The opinions, findings, and conclusions expressed in this summary are those of the contractor and not necessarily those of National Highway Traffic Safety Administration.

Availability: This report may be ordered in paper copy (PC) or microfiche (MF) from NTIS. Order by DOT/HS-800 525.



executive summary

A SYNOPSIS OF A RECENTLY RELEASED NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION RESEARCH REPORT

MULTIDISCIPLINARY INVESTIGATIONS TO DETERMINE RELATIONSHIP BETWEEN VEHICLE DEFECTS, FAILURES AND VEHICLE CRASHES FINAL REPORT

The purpose of this project was to investigate and determine motor vehicle crashes and occupant injury causation, and to determine the relationship between vehicle defects, malfunctions, and subsystem maladjustments contributing to those crashes.

Contract FH-11-7254
Baylor College of Medicine
Department of Psychiatry
1200 Moursund Avenue
Houston, Texas 77025
DOT/HS-800 377 PB-197 701

Award Amount: \$74,010.00
Contract period: June 18, 1969
to April 30, 1970
Report Rec'd: March, 1971

General Comments

Investigations of 34 motor vehicle crashes were conducted by a multidisciplinary team of investigators from Baylor College of Medicine in Houston, Texas between June 1969 to March 1970. The primary research objective was to determine the extent to which vehicle system and component defects, malfunctions, and vehicle subsystem maladjustment cause or contribute to crashes. Each crash case underwent a series of investigations which included a careful vehicle inspection and its various mechanical components post-crash, an analysis of the crash site and its role in crash causation, and a study of the driver's behavior as it related to the crash.

Methodology

The methodology employed in these investigations considered:

- Vehicle pre-crash safety condition;
- The relationship between the degraded vehicle subsystem condition and vehicle performance in the pre-crash period based upon both objective and subjective evaluations;
- The nature of the crash, and

- The environment of the crash site.

To determine the relative degree of causation-contribution of the driver, the vehicle, and the crash site environment, the team devised a rating system to identify the role of each of the factors involved.

In each of the crash cases summarized in the report, only the most significant aspects of each case are reported. Basically, each case summary contains the following information:

- Identification of where the crash occurred, and at what time;
- The ambience of the crash, including the hour of occurrence, significant weather conditions, temperature, humidity and other factors;
- A brief description of the roadway on which the crash occurred, with a description of the roadway measurements;
- A brief description of traffic controls, describing lane markings, traffic signals, and obstruction to traffic controls, if any;
- Vehicular descriptions of basic characteristics of vehicles involved and the approximate amount of damage to each;

- Occupants and descriptions of injuries received by them in each involved vehicle;
- Brief description of the pre-crash, at-crash, and post-crash dynamics, and significant events;
- Major findings from each case. In this section of each case summary the causal factors, conclusions, and recommendations are set forth using a matrix cell criteria system developed by the National Highway Traffic Safety Administration Crash Investigation Teams (Illustration given in the report).

MAJOR FINDINGS, CONCLUSIONS, AND RECOMMENDATIONS

○ Findings and Conclusions

Very few true vehicle defects were found. The vehicles investigated did not lack completeness or have imperfections of their particular subsystems necessary for minimal safety performance when new. They did conform to the laws of mechanical physics and wear over time; hence their incompleteness, imperfection, or fault was a secondary product, not a primary one. It therefore seems inappropriate to call these "primary defects"; in many, the automobiles were perfectly adequate up to a certain point in their usage and secondarily developed parts wear which give rise to a "secondary defect". Some cases, were not so clear, but they possess an innate and very high degree of probability that the driver was the "primary defect".

In other cases where no personality abnormality could be identified, there was no evidence of a "primary defect" in the automobile. Even in these cases, the vehicle subsystems had simply worn out over prolonged use without proper maintenance.

There are three aspects to these conclusions which are relevant. The *first* is an elaboration of the results concerning each subsystem component which hypothetically contribute to a crash. That is, which subsystem most often caused or contributed to a crash. The *second* consideration is the relationship of a driver's personality as it translates itself into proper or improper maintenance of his vehicle and secondarily how his personality directly translates itself into normal or abnormal driving practices. The *third* aspect that necessitates meaningful conclusions is what type of ambience features give rise to more serious crashes or injuries.

There may be vehicles on the road with defective brakes; many drivers neglect the maintenance of their vehicles and this translates itself into unsafe machinery

on the road; many drivers, because of their basic personality patterns or stress they are currently undergoing, translate this into unsafe driving practices; many roadway features help produce lethal resting points, some may be just troublesome areas to negotiate. But it is the responsibility of the investigators to attempt to correlate the various factors, and observe whether there are certain recurrent total patterns which can be described, whether vehicle, driver, or ambience.

○ Vehicle Defects

The hypothesis that primary vehicle defects are a significant contributor to crash causation is questionable. Seventy-six percent (76%) of the experimental sample in this study had defects which caused or contributed to a crash. None of these defects were caused by a "lack of something necessary for completeness" (Webster's definition of defect) when the vehicle was new. The defect was a product of subsystem part degradation through prolonged use.

"Secondary defects" deserve special examination in helping to reduce the incidence and severity of crashes. Brakes were the most significant subsystem that caused or contributed to the case crashes investigated. Over 50% of the vehicles examined had over 45,000 miles registered presumably without having had the brakes replaced. Others had over 30,000 miles on the odometer.

Since brakes were the most frequently degraded subsystem, then any licensing inspection would minimally have a more severe requirement on brakes on vehicles with over 45,000 miles on the odometer; maximally, this rigorous inspection should cover all vehicles with over 30,000 miles on the odometer. Theoretically, all vehicles with brake degradation should have been picked up if maximum inspection requirements covered all vehicles with an excess of 30,000 miles on the odometer.

A second group of "secondary defects" were categorized under the heading of "steering-suspension" although this category did not cause crashes of the vehicles examined, it did contribute to 20.5% of those crashed. Included under this category are degraded power steering systems, idler arm wear, worn bushings, etc. The steering-suspension system should also be inspected along with the brake system even though if priorities must be established, the steering-suspension system would have to be rated a low priority for inspection when compared to brakes.

Although tires were lower than the steering-suspension

system as a total causative-contributory factor, tires were the only other subsystem besides brakes that were rated as causative in a crash. If priorities should be established, tires must have a thorough inspection.

To summarize, subsystem inspection should follow this order:

Brakes

Tires

Steering-suspension

○ Driver Personality Abnormalities

Sixty-five percent (65%) of the drivers in the cases studied were diagnosed to have abnormal personality functioning. Among those who were diagnosed a psychological normal, only one had driven a vehicle with a subsystems defect which was causative in a crash. Of those drivers rated abnormal, approximately 45% of their vehicles had subsystems defects that were crash causative.

○ Ambient Causation

Analysis of the crash cases indicates that ambience contributed toward causation. Contributory factors were such as: lack of traffic markings and signals, poor channelization, poor shoulder and street surfaces, obstruction of vision, and fog.

○ Recommendations

- Licensing examinations should have a more severe requirement on brakes inspection.
- Vehicles with over 45,000 miles registered on the odometer should have a much more rigorous inspection of the brakes than those with less than 45,000 miles.

– Any vehicle over three years of age should have a much more intensive brake inspection.

– A system that would indicate excessive brake wear could be installed using a small pin which contacts the drum with a measured amount of disc wear. This could then activate a light on the dash indicating the brakes were degrading.

- Rigorous inspections of vehicles would not change abnormal personality pattern, but it would assure that a person with a deviant personality pattern would be driving a vehicle with minimal integrity of significant subsystems essential for driving safety.
- Improve markings, channelization, and traffic control devices. Conduct periodic maintenance of road and shoulder surfaces. Remove utility structures and other hazardous fixed objects from adjacent roadway area. Improve visual warning devices to alert the driver that reduced speed is necessary ahead. These are some of the recommendations for ambience remediation.

The opinions, findings, and conclusions expressed in this summary are those of the contractor and not necessarily those of the National Highway Traffic Safety Administration.

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